POWER

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Arguments for Purchased versus Produced Power

AN ARGUMENT that is used with telling effect by the salesman of central-station current is that the money that would have to be invested in a power plant, in the case of a new installation or in the reorganization on modern lines of an existing plant, would yield a larger return if invested in the productive processes of the business.

This is probably true if the business is assured of a generous profit and if it has little use for steam for heating and manufacturing processes.

But it is pertinent only if the prospect's credit is limited or if the business is profitably capable of expansion to an extent that will absorb all his available means.

If he has enough money available, above what he can advisedly invest in productive machinery, to include a power plant in his new enterprise or to reorganize his present plant along efficient lines, he may find that he can earn a handsome profit by generating his own power.

True, the cost of power is a small percentage of the total cost of production in many industries, but it amounts to a considerable sum when expressed in dollars per annum.

And, in the broader view, it is an economic crime to pour into the rivers vast quantities of heat that might be usefully applied.

The demonstrated practicability of generating steam at high pressures and temperatures and the availability of prime movers that can extract power from this steam and exhaust it in a still superheated condition and at pressures at which live steam is commonly generated for other than power uses, presents large possibilities in this direction.

Then there is the fact that the user of purchased power is to an extent foot-loose. If his business goes to pot within five years, he will be better off not to have put additional money into a power plant.

If this prospect is imminent, he would be better off not to go into it at all. But if the enterprise thrives for five years, he ought to get back the cost of a good steam plant and have it free and clear for the rest of its useful life, in the case of many existing plants and of projected ones where a demand exists for heat.

F. R. Low

Elevator Equipment in a Large Office Building

DESCRIBES the elevator equipment of the Equitable Life Assurance Society's 22-story building in New York City. There are 29 elevators, of which 24 are in regular passenger service. These machines are of the 1:1 gearless traction type and have a modified form of variable voltage control.

BY C. R. CALLAWAY
Vice-President, Gurney Elevator Company

NO PART of the planning of a modern office building is of greater importance than that which has to do with the elevator service. If the elevators are too few in number, or if they are so designed and located that they are inadequate to the requirements of the traffic, the results are dissatisfied tenants and loss of revenue. The installation of too many elevators means an excessive investment, loss of rentable floor space, and an increase in maintenance, operating and power costs. Therefore in whatever light the problem may be viewed, it becomes one of vital economic importance. The elevator equipment in the new home of the Equitable Life Assurance Society, New York City, is a good example of a modern elevator installation designed to meet economically the needs of a high-class office building.

The structure is 22 stories high, with a 4-story penthouse above the main roof level, containing the machine rooms, and below the ground floor are three basements. It was designed to be occupied eventually solely by the owners, with a tenancy of 6,900 persons, but for the present part of the space is rented, and the population is 5,400. The total rentable floor space is 600,000 sq.ft., almost all of it designed for office use.

After a careful study of all the requirements by E. E. Ashley, mechanical and electrical engineer for the architects, Starrett & Van Vleck, 26 passenger and 3 freight or service elevators were provided. Of the elevators, 26, including the high-rise freight, are of the double wrap gearless traction type with 1-to-1 roping, with a car speed of 600 ft. per min. The machines, controllers and motor-generators for these elevators were supplied by the General Electric Co., and the remaining equipment by the Gurney Elevator Co. The building is in charge of George Haines, operating manager for the owners.

Fig. 1—Equitable Life Assurance Society's Building

The main passenger elevators, 24 in number, are divided into four banks of six cars each, two banks on either side of the main lobby, and are operated by a modified form of variable-voltage or Ward Leonard control, which embodies a number of new features. The original variable-voltage control system as applied to elevators consists of a shunt-wound motor connected to the elevator machine and a generator driven by a constant-speed motor, which in turn is driven by the incoming supply of power. The armature of the elevator motor is permanently tied electrically, except in emergency, to the armature of its driving generator. The elevator motor operates with a substantially constant and uni-directional shunt field, but the generator has a separately excited shunt field which may be connected to or disconnected from the line, varied in strength, and also reversed, by the control equipment, responding to manipulation of the car switch by the operator. The speeds of the elevator motor and car are controlled entirely by the strength of the generator field, and the direction of rotation and car movement by its polarity.

Although the variable-voltage control system provides a wide range of speed control, it has been open to the objection of poor speed regulation, when applied to elevators in its primitive form; that is, the car speed for a given controller point varies between wide limits as the load varies. Recognizing that this disadvantage of poor speed regulation exists in the unmodified variable-voltage control

system, the designers of the elevators in the Equitable Life Assurance Society's building provided them with a new modification of variable-voltage control, known as the "series-exciter" system.

In general, this modified system of variable-voltage control consists of a small exciter with its armature connected in series with the shunt field of the generator and exciter's field winding in series with the armature of the generator. As the load hoisted by the elevator increases and the speed of the elevator motor tends to decrease, the series exciter generates a correspondingly increasing voltage, thus strengthening the shunt field of the generator and sustaining the elevator motor speed. As the load overhauls the elevator motor, its armature generates current, thus reversing the polarity of the voltage generated by the series exciter, weakening the generator field and reducing the generator voltage, and thereby counteracting the tendency of the elevator motor to overspeed. The curves on Fig. 6 show the speed regulation obtained on one of the elevators in this installation, on the first, or lowest, and the sixth, or highest, speed-control points of the car switch.

Each motor-generator used on this installation, in addition to the exciter mentioned, consists of a 25-kw. direct-current generator and a 40-hp. direct-current motor, the three units being direct connected and operating at 1,200 r.p.m. One motor-generator is provided for each elevator motor, each set being started by an individual starting panel mounted directly over it. The starting panel provides line contactors and automatic current-limit acceleration, and the starting and stopping are controlled both by push buttons on the panel and by key switches in the elevator car, under the control of the operator.

The elevator motor is particularly designed for the exacting mechanical and electrical requirements of high-grade, high-speed service. The motor shaft and armature spider are one integral, hollow, alloy-steel casting, affording a unit of maximum strength and of low inertia. The driving sheave and brake wheel are also cast as a single unit, which is pressed on a seat on the combined spider and shaft of large diameter, then doweled and bolted to it. The bearings are of the self-aligning type, lubricated by disks bolted to the motor shaft dipping into and carrying oil from the storage reservoirs in the bearing bases to auxiliary reservoirs above the bearings, which in turn feed the journal surface by gravity.

The following electrical protective features are provided:

1. Hand-operated emergency switch in the elevator car.
2. Automatic slow-down and stop at terminals.
3. Emergency stop just beyond terminals in case the normal slow-down and stop limit switch should fail.
4. Emergency stop in case of overvoltage.
5. Emergency stop in case of overspeed.
6. Emergency stop in case car safeties set.
7. Emergency stop in case counterweight safeties set.
8. Emergency stop in case compensating cables foul.
9. Emergency stop in case of overspeed of motor generator.

In each of the foregoing cases the emergency stop consists of simultaneous opening of the motor armature circuit and application of emergency dynamic braking, as well as an instantaneous application of the solenoid brake.

The car-control switch panel, which provides for six different speeds, is set flush with the car enclosure at the operator's left, and contains also the auxiliary switches. The car floor has an area of 36 sq.ft. and the normal capacity of the car (3,000 lb.) allows 83 lb. per sq.ft., while at the maximum capacity (3,600 lb.) a load of 100 lb. is allowed per square foot, which is

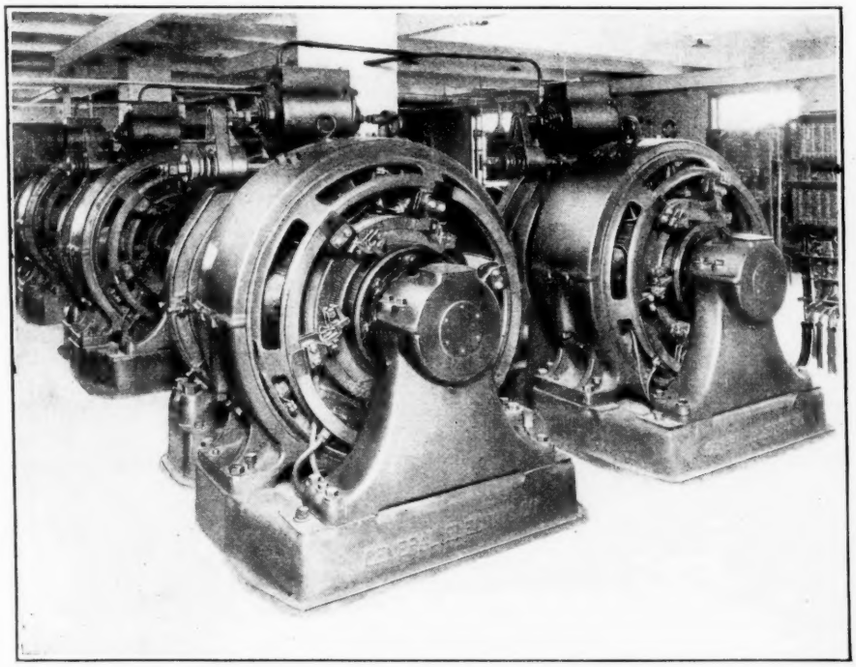

Fig. 2—Battery of gearless traction-elevator motors controlled by variable-voltage control system

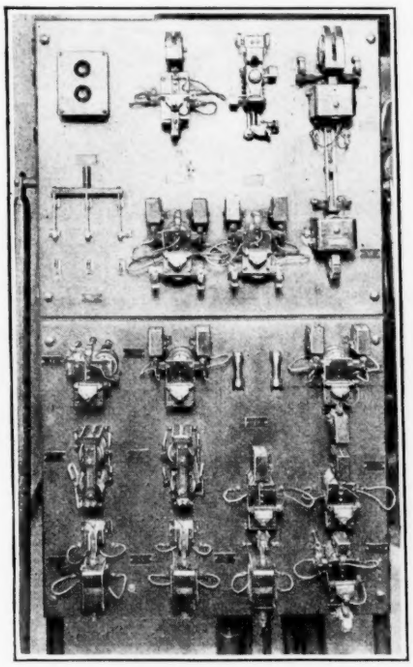

Fig. 3—Variable-voltage control panel

sufficient for any number of passengers that possibly could crowd inside.

The car safety is of the wedge-clamp compression type and stops the car by gripping the guides, one at each side, with heavy steel jaws. It is important to avoid unequal division of the total retarding effect developed between the two pairs of jaws, as this would tend to wrack or distort the car frame out of square

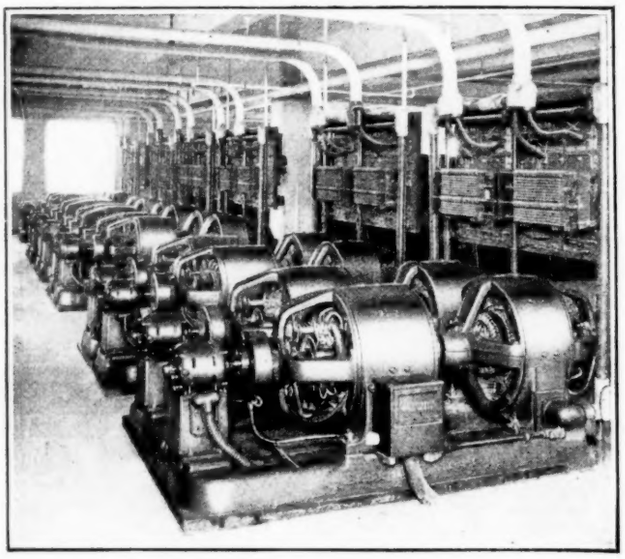

Fig. 4—A battery of motor-generator sets showing the series exciter on the left

and, in extreme cases, might even cause one or two guide shoes to leave the guides. Equalization of the gripping pressure of the jaws has been insured by the following features of construction:

(1) The use of self-aligning faces on the jaws. (2) The machining of the jaw wedges, which are true, straight-faced wedges where the jaw rollers bear when developing pressure between jaws and guides. (3) Floating the shaft or screw, which is threaded right and left hand to fit corresponding threads on the two wedges. This shaft is a free fit in the cable drum and releasing gear, which are feathered upon it, and thus can slide longitudinally as much as may be necessary to pull with the same force on each wedge.

A failure of the safeties, due to improper maintenance, has been guarded against by the use of a non-ferrous metal for one of the elements of every moving joint in the car safety, the governor which actuates it, and the clutch on the car which releases the running cable when the governor grips it. A bronze tail cable is also used to connect the governor cable to the safety drum. Thus, with no more lubrication than the parts received when they were assembled, the device can be depended upon to operate even though it has remained in disuse for a long period of time.

Another desirable feature of a governor is that the gripping device shall not damage the running cable. This has been accomplished by using a long, self-aligning jaw, pivoted on the end of a lever, and having a smooth round groove to fit the cable, which can be gripped practically any number of times without damaging the strands.

The safety governors are of the centrifugal type and operate when the car attains excessive speed. An independent set of balls is provided to open a slow-down contact at a slower speed than that required to throw out the balls, which releases the car-safety, cable-gripping device. As all the balls are of the overhung type—that is, having their centers of gravity above the fulcrum pins—they are free from variation in tripping speed due to varying rates of acceleration, and are sensitive, always tripping with a negligible variation from the rate of speed. Weights are used to retain the balls, thus insuring permanence of setting.

Independent governors are used for car and counterweight safety devices, the latter being required on all electric elevators except the four that travel to the second sub-basement. There is occupied space under the pits of the other 23 electric elevators, and for this reason a counterweight safety device is necessary. The overbalance, or excess of counterweight over the dead weight of the car, is 40 per cent of the normal load, or 1,200 lb., and 15-lb. guide rails are used for both car and counterweights.

Regardless of the construction of the operating equipment no elevator car can have smooth running or riding qualities unless the guides are in alignment. In this installation the utmost care was used in aligning the guides, and the cars start, run, reverse and stop with noticeable smoothness, resulting in an absence of unpleasant sensations to the passengers. Both car and counterweight guides are provided with stationary-type lubricators.

The roping being of the one-to-one double-wrap type,

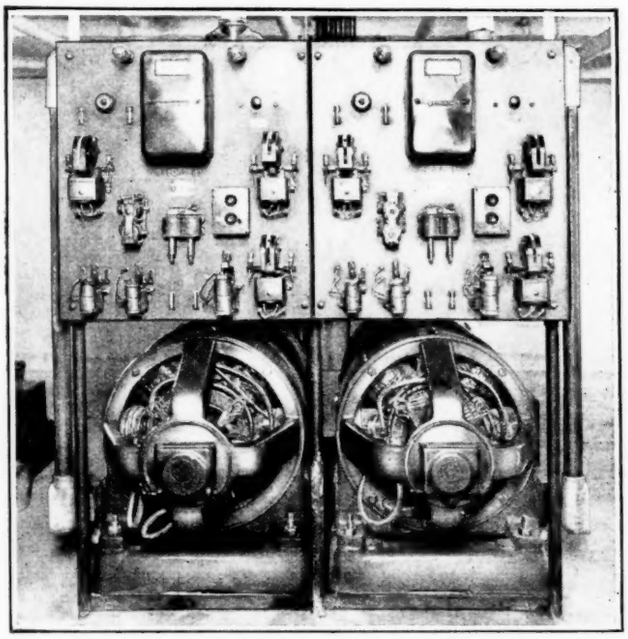

Fig. 5—A pair of motor-generator sets with starting panels

the traction sheaves on the machines have round or "U" grooves. The hoist cables are anchored on the top of the car and at the counterweights in adjustable spring hitches. Six hoist cables are used, each ⅝ in. in diameter. The cables used on these elevators are Roebling's 6x9 Seale lay traction steel.

For the idler sheave, self-aligning, spherically seated roller bearings are used, with ample lubricating reservoirs, so that they will require attention only at long

intervals. For the horizontal shaft of the car and counterweight safety governors, which carry the weight of the governor cables, for the governor cable tension-weight sheaves, and for the tension-weight sheave for the compensating cables, roller bearings are used. Thus at these points lubrication or other attention will be needed only once or twice a year.

As the tension-weight sheave for the compensating-cables must be located between the car oil buffer and

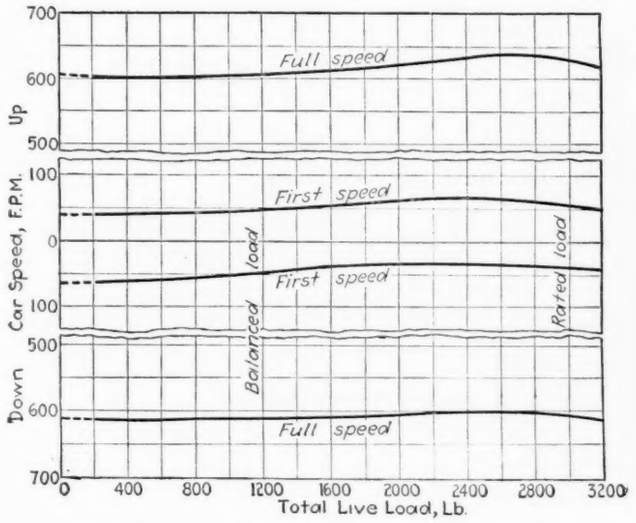

Fig. 6—Speed regulation curves at slowest and highest car speed

the counterweight clearance, the diameter of the sheave is limited and is not great enough to permit the satisfactory use of $\frac{3}{8}$-in. cables, so $\frac{1}{2}$-in. is the size used. Eight are provided, which, together with the assistance they get from the electrical cables and air hose running to the car, equal the weight of the six $\frac{3}{8}$-in. hoist cables. Furthermore, in order to reduce the amount of weight needed to keep the compensating cables straight, they are of 8x19 construction, which is more flexible than standard or 6x19 cable. Contacts are provided on the tension weight, to prevent the running of the car unless the tension weight is hung within certain limits of travel.

All cables, whether hoist, governor or compensating, are socketed by the straight-end, spelter method, which develops practically the entire strength of each wire in the cable, and has been found in practice to be more dependable than the method of turning back the ends and using babbitt metal.

The normal and final limit switches are intended to stop the elevator when the car reaches either terminal landing, and the car or counterweight safety device will stop it at any time excessive speed is attained. As a further emergency precaution oil buffers are provided for gradual mechanical retardation at the extreme limits of travel. One buffer is stationary under the car in the pit, and the other is attached to and travels with the counterweights. The reason for this difference is that the mass of the counterweight complete is fixed, equaling that of the car plus 40 per cent of the rated load; attaching the buffer to the counterweights thus saves its mass in other material.

All hoistway doors and car gates are opened and closed by pneumatically operated devices. Those on the hoistway doors are known as the side-arm type, with a pneumatic cylinder and piston which supplies the power to open the doors and compress a spring. When the air pressure is released from the cylinder, the spring closes the doors in the same manner as with a manually operated closing device. All doors are of the center opening type, but only one operating device is used for each opening, connected to one of the doors.

The gate and door devices operate simultaneously and are controlled by the operator by means of a small lever conveniently located in the car. They are timed to open and close the doors and gates in about 3.25 sec., which is as rapid as is consistent with safety.

A gearless freight elevator is provided, with rheostatic control, serving the building from the second sub-basement to the 24th floor. While this elevator is normally rated 3,000 lb. at 600 ft. per min., it has a maximum capacity of 6,500 lb. at reduced speed, if counterweighted for 50 per cent of the total load. It is somewhat of an innovation to provide a high-grade, high-speed gearless elevator for freight service, and the results thus far have justified this provision. The rheostatic control provides six hand-control speed points in the up and down directions, the particular feature of this control being a large number of automatic speed points, thus giving a smooth acceleration and retardation and relatively low current peaks on the motor.

A similar gearless rheostatic passenger elevator is provided for special service in one of the outlying wings of the building and runs from the second to the 18th floor. These two gearless elevators were selected with

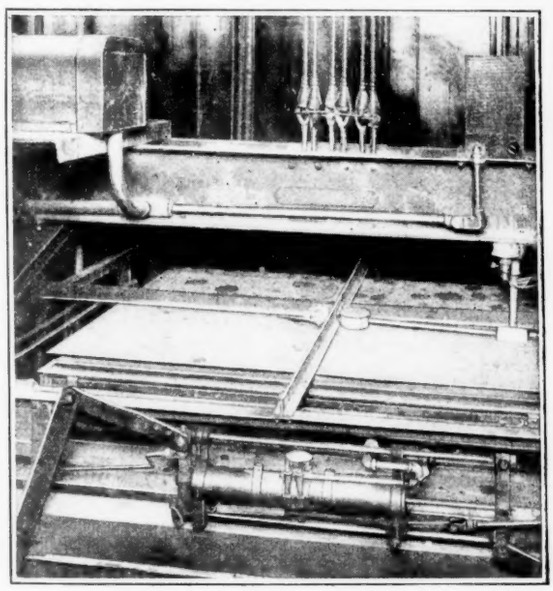

Fig. 7—Top of a passenger elevator car, showing field resistor on right and limit switch on left

rheostatic control, both because of location and because the service required of them did not demand the highly refined operation of variable-voltage control.

A geared rheostatically controlled elevator for executive office service operates from the 17th to the 22d floor and is designed for handling a maximum load of 1,500 lb. at 250 ft. per min. Two service elevators of the hydraulic plunger type operates from the second sub-basement to the first floor for freight service only.

Outlook Promising for the Small Power Plant

Present Industrial Conditions Awaken Interest of Executives in Power Problems—Keener Competition Reflected in Central-Station Returns

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SO PRONOUNCED has been the increase in output from central stations and the psychological effect of the large figures that many believe the isolated power plant is a thing of the past and in a few years there will be no small power plants. That this view is not well founded is now evidenced by rather widespread interest among industrial executives in their power problems. And this interest is of a substantial nature because all costs are now being more carefully analyzed —power costs and heating costs as well.

During the war and for a considerable period thereafter the demand for goods was so great in many lines that cost of production was not considered a serious matter. The prime consideration was quantity production of goods. No one wanted to make power if it could be purchased. Everybody was thinking of making goods with little thought as to costs so long as they obtained production. The central stations were all making large increases in gross earnings, and their net earnings were such that new capital could be easily attracted with which to make extensions to distributing systems and refinements in power plants.

In fact most of the developments of recent years along the lines of cheaper power production have been in the central-station plants. But manufacturing facilities in the meantime in all lines were tremendously increased. And now the conditions confront us that more goods in many lines can be made with the facilities at hand than can be readily absorbed. The result is keen competition in manufacturing.

Executives Delving Into Power Problems

Many industries now complain that profits are too small. And contrary to conditions in the recent past, one cannot now raise the selling price and thereby increase profits because of the competition. So the next best thing is to cut the costs. And the wide-awake executive is in a receptive frame of mind to cut costs in all departments, including the power plant.

Heretofore, there has been less attention given by managements to the costs of power than almost anything else in industry. In the past both coal and labor were comparatively cheap and power was relatively such a small item in the final cost sheet that it was looked upon by executives as unimportant. But coal is now at least double and in some localities three times the price it was fifteen years ago. The quantities used in industries have not materially decreased, and the men who fire the coal now get at least twice the wages they did a few years ago. So that now heat problems are of much greater magnitude than before.

Naturally, in the early stages of the campaign by the central stations the poorest isolated plants were the first to give way. The better ones remained until rate reductions made possible by the improvements in central station practice made it impossible for some to compete, and they gave way to the centralized power scheme. Then, gradually, improvements in operating the remaining small plants began to appear where formerly good operation was generally unheard of.

Industrial Plants Adopting Refinements

The central stations' drive for power business was checked in an appreciable way but not stopped, because power rates gradually came down. Then some of the refinements, heretofore generally unknown except to central stations, began to appear in industrial plants. Higher steam pressures and stoker firing are now common and are rapidly taking the places of low pressures and hand-firing methods. Superheated steam and higher working temperatures are rapidly finding favor in industrial plants. In short, changed conditions are causing industrial executives to seek every possible avenue of gain for the money they pay out for coal.

The uniflow engine with its relatively flat steam curve has greatly reduced the steam the prime movers take during the periods of light loads and bleeder turbines are making possible a better heat balance. Many plants with widely variable loads and of relatively small sizes are now successfully competing with the central stations, which a few years ago was considered impossible. A better knowledge of the uses of exhaust steam is rapidly being disseminated among business executives, and power and heat problems are being considered jointly instead of separately as formerly.

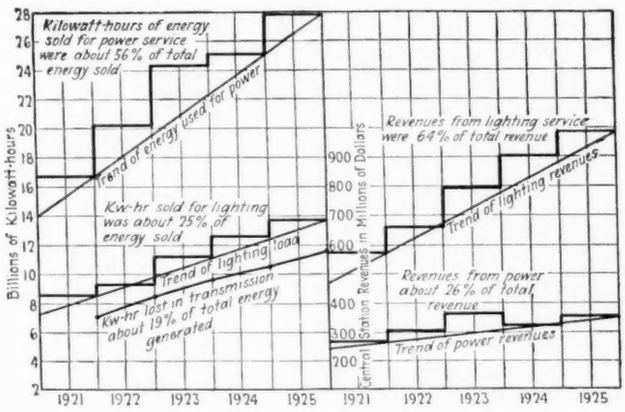
The central station is in a measure a monopoly and is generally protected in its field of operation from the encroachment of competition from other companies. Public utilities cannot and do not now compete with one another, but they still have the natural competition from the better class of private power plants. That this competition is a factor to be reckoned with can best be disclosed by a review of the central-station business of the entire country for the last five years.

From 1921 to 1925 the energy generated by the light and power companies of the United States increased from 37,000,000,000 to 59,500,000,000 kw.-hr. This is an increase in the electrical energy produced of 61 per cent in five years. During this period the gross revenues increased slightly over 55 per cent. This for the whole volume of business is a very satisfactory showing. It will be interesting to see how the revenues and vol-

ume of energy are divided between light and power. In 1921, 8,500,000,000 kw.-hr. were sold for lighting (including domestic services) and produced revenues of $570,500,000. By 1925 the lighting and domestic business had increased to a point where it furnished an outlet for 13,670,000,000 kw.-hr. and produced revenues aggregating $988,000,000. That is, in the lighting field the electrical energy sold increased 61 per cent and the revenues derived therefrom increased 73 per cent.

In the power field, however, which is highly competitive with the private power plant, we find in 1921, that 16,730,000,000 kw.-hr. were sold for $267,800,000. In 1925 27,867,000,000 kw.-hr. were sold for power purposes and produced revenues of $349,000,000. That is, the energy sold increased in five years 66 per cent and the revenues derived from the sales of this power energy increased only 30 per cent.

The average yield from the energy sold for power purposes in 1921 was about 1.6 cents per kilowatt-hour


Kilowatt-hours of energy sold for power service were about 56% of total energy sold
Trend of energy used for power
Kw-hr sold for lighting was about 25% of energy sold
Trend of lighting load
Kw-hr lost in transmission about 19% of total energy generated
Billions of Kilowatt-hours
Revenues from lighting service were 64% of total revenue
Trend of lighting revenues
Revenues from power about 26% of total revenue
Trend of power revenues
Central Station Revenues in Millions of Dollars
1921 1922 1923 1924 1925 1921 1922 1923 1924 1925

Trend of central-station business in United States for period of 1921-1925

Does not include power for electric railways nor that sold to other power companies

and in 1925 it had dropped to 1.25 cents, a decrease in the average rate yield from power sales in the five-year period of 22 per cent.

The trend of the central-station business for the last five years is shown graphically in the attached chart. (This does not include power used for railways nor sales to other companies.) Note that the lighting revenues and lighting energy are traveling in fairly parallel lines with a slight tendency to come together. But the power energy and the power revenues are traveling in lines divergent from one another.

The central-station business so far has been developed in competition from what might be called in the main a moderately fair class of private plants. As these plants go to greater refinements in design and in operation, the business in this field will yield less profitable business to the central station and manufacturers of first-class equipment will find larger and ever growing business from the industrial power field.

The central stations have performed a wonderful feat in the development of their industry up-to-date and they have rendered a truly valuable service to the country as a whole. There is a solid field in which this industry can permanently operate, but the trend of its business development must change from that which the last five years discloses. Competition in the power field will become harder and harder.

Factors in Piston Design

The Mechanical Engineering Department, Purdue University, has published in Bulletin 25 the data obtained in a series of tests to determine the flow of heat in gas-engine pistons of small diameters. As a result of these studies the following conclusions were drawn:

1. The piston head of uniform section is the best conductor of heat.

2. The short barrel of tapered section is the best dissipator of heat.

3. A head section thick at the circumference will assist in the dissipation of heat. For this reason a large fillet is recommended at the junction of the head and the barrel.

4. The addition of metal to the head lowers the maximum temperature more than the same volume of metal applied to the barrel.

5. The barrel should be as thick as the head section at the head end and as thin as practicable at the open end.

6. Ribs, when properly designed, improve the conductivity more than an equal quantity of metal added to either the head or the barrel.

7. The proportions of the head, the barrel, and the ribs are mutually dependent for best performance.

8. The triangular rib extending from the center of the head to midway the length of the barrel is the most effective.

9. A large number of thin ribs is superior to a few ribs of the same total thickness, since it gives better heat distribution over the head and the barrel.

10. Between 60 and 85 per cent of the total heat is dissipated from the ring belt in the usual type of piston.

11. The conventional ring belt is about 60 per cent as effective as the piston skirt in dissipating heat with the same temperature difference.

12. The ring belt should be as short as possible.

13. A broad bearing land within the ring belt will improve the heat emission.

14. Piston rings that make good thermal contact with the piston should be used for maximum cooling.

15. A gray-iron piston-head section should be designed for conductivity rather than for strength.

16. Gray iron should be fine-grained and homogeneous for thermal conductivity.

17. Low density, low coefficient of expansion and high coefficient of conductivity should characterize the piston material.

Whether we consider power, economy, smooth running or friction in an internal-combustion engine, the piston stands out as an important factor. In the interest of good performance the most desirable qualities in a piston are light weight, low temperature and minimum distortion, but since they involve conflicting principles, the accepted design is essentially a compromise.

From the 33 operating companies reporting on transformer bushings, to the Electrical Apparatus Committee of the National Electric Light Association, twenty of them indicated a total of 441 bushing failures during 1925. These failures concerned all types, plain porcelain, compound and oil-filled insulators. Failures where not protected by lightning arresters numbered 163; where protected by valve-type arresters, 99; and where protected by other types 179 failures.

How To Lay Out Power-Plant Piping—III*

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THE author discusses briefly the influence of high temperatures on the choice of materials and gives an illuminating exposition of the development of dimensional standards, a subject on which he can speak with authority because of his service on the A. E. S. C. committee doing this work.

WITH the general layout planned, and pipe sizes selected, it is well to decide upon the nature of the materials to be used and to select the dimensional standards that are suitable for the job. These, of course, depend upon the pressure and temperature the piping must stand, and in some cases upon the chemical nature of the material to be carried.

Selection of Suitable Materials

Piping systems have been operated for a good many years handling water or air under pressures of two to three thousand pounds per square inch at atmospheric temperature ranges. There is no particular difficulty in obtaining satisfactory materials for such service, but the safe handling of steam or oil under comparatively moderate pressures at temperatures of 700 deg. F. or higher is quite a different matter. The large saving in power station fuel which could be secured by operating turbines on superheated steam at high temperatures[1] is limited at present by the decrease in strength of available materials with increase in steam temperature.

The tensile strength of some piping materials tends to increase with reference to their strength at atmospheric temperatures for a few hundred degrees and then falls off rapidly with further rise in temperature. Certain other materials show a continuous decrease in tensile strength with increase in temperature. Considerable experimental work has been done in the last few years to determine the strength of materials at elevated temperatures. In May, 1924, a "Symposium of the Effect of Temperature Upon the Properties of Metals" was presented at a joint meeting in Cleveland of the American Society of Mechanical Engineers and the American Society for Testing Materials. The reports and discussion presented in the symposium have been published in the records of the two societies. A few curves taken from these reports are reproduced here in Fig. 1 to illustrate the point under discussion. These curves should not be considered as applying to all metals of similar composition, and they are given here merely to represent the magnitude of change in strength with temperature.

Another peculiarity exhibited by certain metals such as cast iron, is that while they do not show a serious decrease in tensile strength tests up to 600 deg. F. or so, a prolonged exposure to such temperatures while under stress is almost sure to result in failure.

In fact, as recent investigations have shown, most materials will show a "creep," "flow" or "permanent

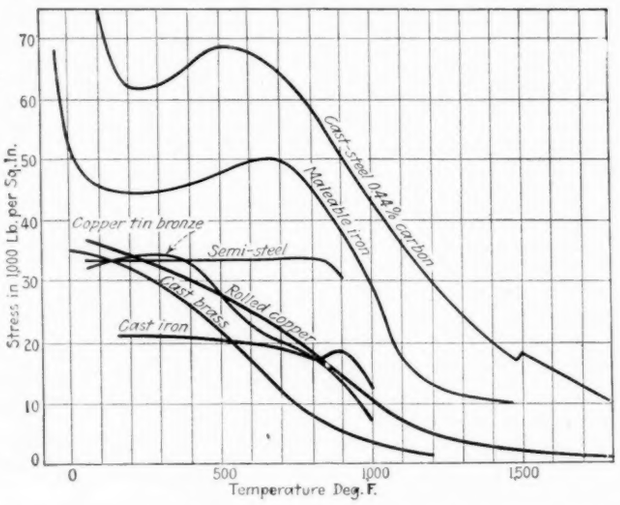


Fig. 1—The effect of temperature on tensile strength is both striking and important

set," as one chooses to call it, with prolonged exposures at high temperatures to stresses that would produce no such effect at atmospheric temperatures. The curves in Fig. 2 have been plotted from data published by Professor Lea[2] to show for certain steels the limiting stresses above which creep will occur at elevated temperatures. The stresses shown in these curves have been plotted in pounds per square inch, against degrees Fahrenheit rather than in long tons per square inch against degrees Centigrade used in the English report.

All this leads to the conclusion that equipment intended for use at high temperature must be designed to operate at lower fiber stress than is permissible for the same equipment for use at moderate temperatures. Further, particular care must be given to the selection of materials that are suitable for high-temperature service.

*Part I in *Power* for May 18, 1926; II, June 8, 1926.

[1]See "Transactions of A. S. M. E. for 1923," papers by Messrs. E. L. Robinson, C. F. Hirshfeld and F. O. Ellenwood, E. H. Brown and M. K. Drewry, W. J. Wohlenberg.

[2]Prof. F. C. Lea, "Effect of High and Low Temperature on Materials"; Institution of Mechanical Engineers, London, December 5 to December 18, 1924. See also V. T. Malcolm, "Metallurgical Developments in the Valve and Fittings Industry," *Mechanical Engineering*, December, 1925.

Several manufacturers of piping material are making thorough investigations to determine what metals are best suited for use at high temperatures, and progress along these lines is rapid at the present time. This work involves not only laboratory tests, but also the close observation of experimental valves, fittings, etc., that have been installed in their customers' plants.

In placing an order for material to be used in high-temperature service, it is necessary to specify at what temperature it will operate and to require the manufacturer to guarantee that it will prove satisfactory for the purpose intended. This is not only a necessary precaution for self-protection on the purchaser's part, but it gives the manufacturer a fair chance either to furnish material that he knows is right, or else to decline the order.

In specifying materials it must be borne in mind that certain metals are not suitable for use with fluids such as ammonia, acids or mercury, while other metals are especially adapted for such service. Similarly, material resistant to corrosion, internal and external, must be used in some cases. While water piping of small size is frequently made up with galvanized material, the extra cost of galvanized pipe and fittings for oil lines is usually not warranted where piping is accessible for painting on the outside to prevent corrosion. For underground work, cast iron, brass, copper or lead pipe, depending on the size, will be most durable and economical, as they all resist corrosion to a high degree. Where the question of permanence is not of much moment, the use of black or galvanized wrought iron or steel pipe underground is permissible. Steel pipe properly coated with asphaltum or other protective material is frequently used for underground water pipes three feet or more in diameter. Steam pipes properly inclosed in a watertight conduit are often of steel and have a reasonably long life.

Dimensional Standards

Before attempting to establish a dimensional standard for details such as flanged joints, wall thickness of fittings and pipe, etc., it is essential that a choice of materials be made from those which are suitable for the service conditions, and that an allowable fiber stress be decided on for each material and purpose. Then with these materials and the allowable fiber stress as a basis, the next step is to design the metal sections in each part heavy enough to keep within the stress limit set. If one is pioneering in the use of pressures and temperatures above those for which standards exist, it may be necessary to undertake such designs in one's own organization. However, the Sectional Committee on Pipe Flanges and Fittings, operating under the procedure of the American Engineering Standards Committee and sponsored by the American Society of Mechanical Engineers, the Manufacturers' Standardization Society of the Valve and Fittings Industry, and the Heating and Piping Contractors' National Association, has been working along these lines for the last three years and has published tentative dimensional steel flanged standards for 250, 400, 600 and 900 lb. working steam pressure at temperatures up to 750 deg. F. It has also secured the co-operation of the American Society for Testing Materials in the preparation of Material Specifications for use with the dimensional standards. An A.E.S.C. sub-committee now has under way a standard for 1,350 lb. working steam pressure. So far neither the A.E.S.C. nor the A.S.T.M. committees working on these piping standards have seen fit to recommend materials for use at temperatures exceeding 750 deg. F. In some specifications a clause has been inserted to the effect that "at the discretion of the designing engineer, higher temperatures with appropriate pressures may be used," the intention being to allow a designing engineer to increase the operating temperature a reasonable amount above 750 deg. F., provided he selects a flange standard whose pressure rating at 750 deg. F. is sufficiently above the pressure at which the plant will operate.

Mechanical Design Features

In any event there are certain phases of piping design involving allowable fiber stress and strength of sections that cannot very well be standardized, which must be left to the designing engineer to thresh out to suit his particular requirements. Among these are bending stresses set up through thermal expansion of the pipe line between atmospheric temperature and operating temperature, and dead load stresses arising from the method of support. The wall thickness in pipe and fittings must be sufficiently heavy to keep the total fiber stress within safe limits where the dead weight and expansion stresses just mentioned are combined with the bursting stress resulting from internal pressure.

In the usual type of high-pressure flange joint a narrow gasket face or contact surface is used to obtain a

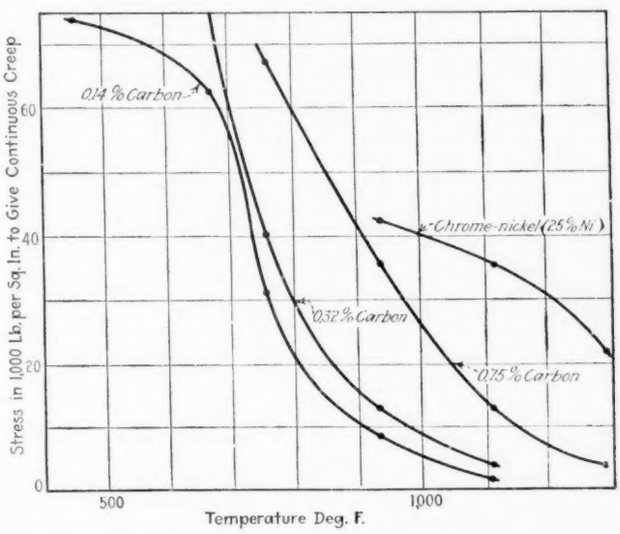


Fig. 2—The "creep" resistance of mild steel decreases rapidly between 700 and 900 deg. F.
From data by Professor Lea.

high unit compression on the contact area. The compression on this surface (and on the gasket if one is used) before internal pressure is applied to the pipe, is generally from eight to twelve times the designed working steam pressure. The effect of applying internal fluid pressure to the pipe is to decrease the compression on the contact surfaces, since part of the initial bolt tension is then required to hold the joint from blowing apart. It is customary to assume that the force tending to blow the joint apart is the product of the internal working pressure times the area circumscribed by the outer edge of the contact surface. Considering internal pressure in the pipe as acting on this area, the gasket compression, after deducting for internal pressure,

should be between four and eight times the working pressure.

Obviously, this all hinges on what initial tension is set up in the bolts when the nuts are turned down, and this is not an easy thing to determine or to maintain uniform in erection. For purposes of calculation in design one may assume some particular working stress for the bolts based on a reasonable factor of safety with respect to their physical properties. In the case of steam lines operating at pressures in excess of 200 lb. gage, the initial fiber stress set up in the bolts through tightening the nuts frequently exceeds a safe working stress for mild steel. In fact, it is easily possible to exceed the ultimate strength of a mild steel bolt by tightening the nuts and actually produce failure. In order to obtain a greater factor of safety with high pressures and temperatures it is good practice to use alloy steel bolting material whose physical properties and endurance at elevated temperatures measure up to the requirements of the service.

Kimball and Barr, in their "Elements of Machine Design," state that the total bolt pull set up through tightening the nuts is 16,000 lb. per inch of nominal diameter of the bolt. The constant 16,000 was derived from the results of a series of tests made at Cornell University. As this formula is deduced from test results, it is empirical rather than rational, and is not susceptible of mathematical proof. However, the tests on which it is based appear to have been carefully made, and are described as follows by the authors: "The sizes of bolts used were ½-in., ¾-in., 1-in. and 1¼-in. One set of experiments was made with rough nuts and washers, and another set with the nuts and their seats on the washers faced off. A bolt was placed in a testing machine, so that the axial force upon it could be weighed after it was screwed up. Each of twelve experienced mechanics was asked to select his own wrench and to screw up the nut as if making a steamtight joint, and the resulting load on the bolt was weighed. Each man repeated the test three times for each size of bolt, and each had a helper on the 1-in. and 1¼-in. sizes. The sizes of wrenches used were 10-in. or 12-in. on the ½-in. bolts up to 18-in. and 22-in. on the 1¼-in. bolts. The results were rather discordant, as should be expected; the loads in the different tests were rather more uniform, as well as higher, with the faced nuts and washers."

If the total load is divided by the cross-sectional area of the bolt at the root of the threads, a value is obtained for the tensile stress t in the bolt in pounds per square inch which is very nearly equal to that given by the expression,

$$t = \frac{30{,}000}{d}$$

where d is the nominal diameter of the bolt in inches. It is evident that if this formula is correct, very high stresses are set up in bolts smaller than one inch in diameter. That such stresses are actually produced in small bolts is evidenced by the frequency with which mild steel bolts one-half inch and smaller snap off when the nuts are being drawn down. The foregoing formula is valuable as a means of calculating the extreme fiber stress to which bolts and flange material may be subjected during the initial tightening of the nuts, but they should not be taken as giving a safe working stress for bolt material.

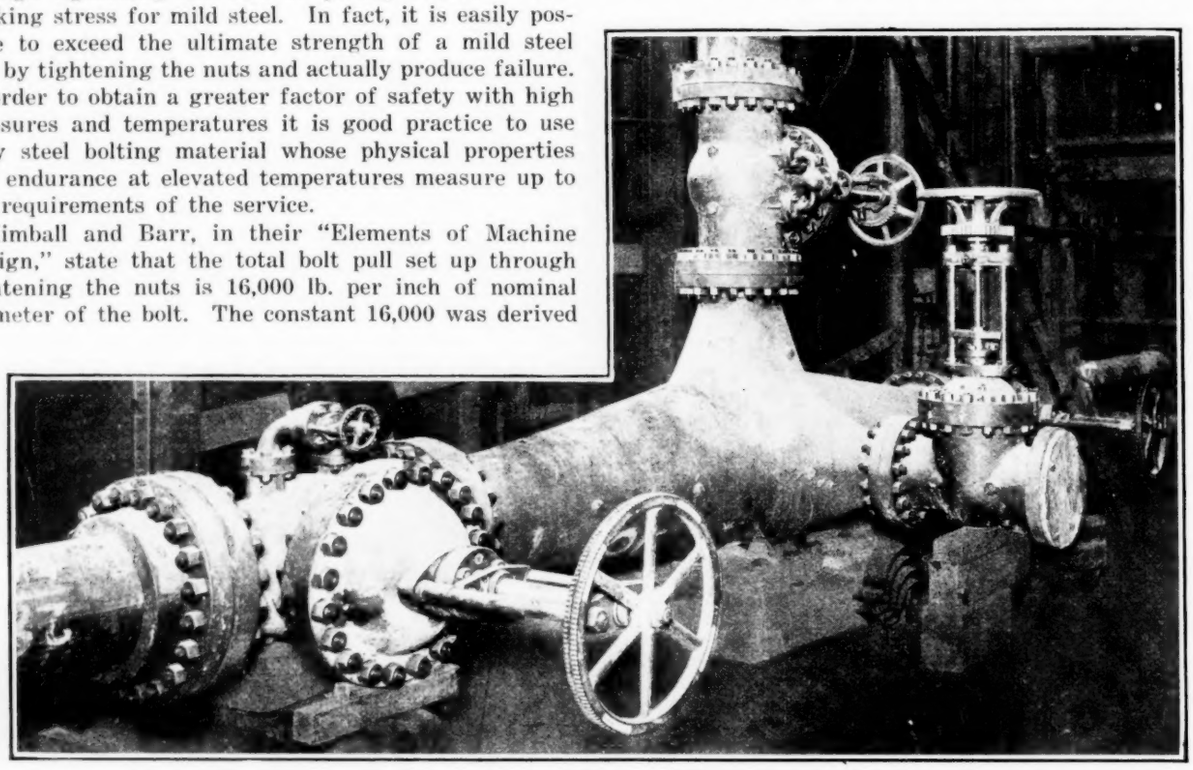


Fig. 3—Fittings designed from the A.E.S.C. 600-lb. standard dimensions. The 14-in. pipe at the left carries a Van Stone joint flange

The following table gives what the author believes are conservative figures for working stresses in flange stud-bolt material for steam lines operating at temperatures up to 750 deg. F. Values are expressed in pounds per square inch. It is the usual practice to use mild steel nuts with all classes of studs listed below since the stresses in nuts are much lower than in studs.

Material	Elastic Limit	Tensile Strength	Safe Working Stress
Mild carbon steel	30,000	60,000	7,000 to 10,000
Heat-treated carbon steel	70,000	95,000	15,000 to 20,000
Heat-treated alloy steel	80,000	105,000	20,000 to 25,000
Heat-treated alloy steel	105,000	125,000	25,000 to 30,000

The values given refer to total bolt tension, which includes initial tension produced by tightening the nuts to compress the gasket, plus any additional stress set up when internal pressure is put on the line. The effect

of torsion has been neglected since its cause is removed when pull on the wrench ceases.

The following quotation from the A.E.S.C. Steel Flanged Standards states what the Sectional Committee considered a safe working stress in bolts with regard to internal working steam pressure only at 750 deg. F., neglecting the initial tension given the bolts in order to compress the gasket. "The allowable working fiber stress considering internal allowable working pressure only, in bolting material for valve bonnet flanges, clean-out flanges, etc. shall not exceed 9,000 lb. per sq.in., assuming the pressure to act upon an area circumscribed by the periphery of the outside of the contact surface."

Flange Stresses

In the type of high-pressure joint commonly used, the bolt circle is a considerable radial distance beyond the periphery of the contact (or gasket) surface. This overhang of the bolts produces large bending stresses in the flange incidental to the initial tension given the bolts when the joint is made up. The initial bending stress set up in the flange by tightening the nuts while the line is cold is so large with regard to any additional stresses produced when the line is put into service that the latter can usually be ignored if the flange is properly designed with regard to the former. The bolt stresses corresponding to internal working pressure are not directly additive to the initial bolt tension produced by screwing down the nuts. The reason for this is that as internal pressure is applied, any further stretch of the bolts tends to let the flange slip back enough to relieve part of the reaction against the gasket. If the gasket has no elasticity or follow-up, the condition would then be approached in which the application of internal pressure could produce no increase in bolt tension until the load due to internal pressure exceeded that due to initial tension. In a pipe joint the load due to internal pressure cannot exceed that due to initial bolt tension because the gasket would blow out long before this condition was reached.[3]

For loose flanges, such as Van Stone companion flanges, it is usually necessary to provide hubs on the flanges which serve to strengthen them in the same way that stiffening angles support flat surfaces on rectangular tanks, etc. In the case of flanged fittings the body of the fitting furnishes the support which is derived from hubs on Van Stone flanges. It is possible, of course, in the case of loose flanges to increase the thickness of a flat flange sufficiently to obtain the required strength, but as in the case of many other flat surfaces, this is not the most economical or desirable method to use. Fig. 3 shows a large manifold casting with 600-lb. A.E.S.C. Van Stone flanges on the adjacent piping which is bolted to it. The hubs on these flanges represent what the author considers adequate design for this class of service.

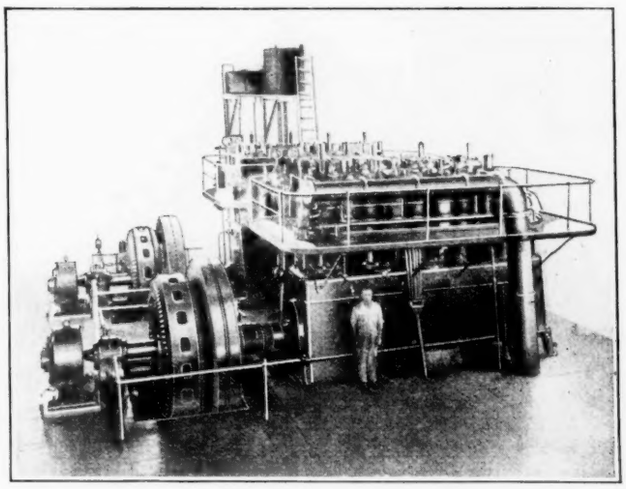
Comparative tests on copper grounding plates buried in coke, treated with salt and with copper sulphate showed that at the end of three months the copper wires leading to the plates buried in salted coke were completely eaten off and a third of the plate area wasted away. The plates buried in coke treated with copper sulphate were only slightly pitted, due to the activity of the various salts in the soil.

[3] An interesting discussion of bolt loading and strain well worth a careful study, is given in Kimball and Barr's "Elements of Machine Design," first edition, pages 168 to 176 inclusive.

Cost of Diesel Engine Operation at New Iberia, La.

Two 400-hp. Diesel engines were installed in the municipal light and water plant of New Iberia, La., in 1924, to replace the existing steam units. Each engine was direct-connected to a 334-kva. generator and a direct-current exciter, the speed being 200 r.p.m.

The economies obtained have been more than satisfactory, the March, 1926, costs being as shown in the tabulation:



400-hp. McIntosh & Seymour Diesels at New Iberia, La.

	Kw.-Hr.
Output	
Commercial	71,000
Street lights	11,240
Power house	3,000
Sewerage and filtering plants	7,500
Water-works, air lift and pumps	58,860
Total	151,600
Expense	
Fuel oil $0.0465 per gal.	$698.17
Lubricating oil	114.27
Kerosene	7.00
Supplies	17.50
Labor	600.00
Overhead charges	580.00
Total	$2,016.94
Total cost per kw.-hr.	$0.0133

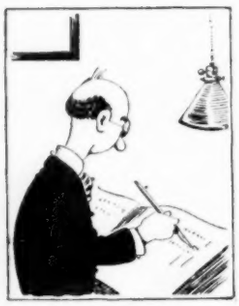
The item of lubricating oil is much greater than the actual cost for oil used on the engine, inasmuch as it includes the oil used in the water-works pumps. A gravity filter is used to clean the engine lubricating oil.

In America and in such mid-European countries as Germany and Austria, there has been much study of the possibilities of combining the supply of power and heat in such a way as to utilize as much of the coal as possible. In British technical journals less attention has been given to the matter, although it has not been entirely overlooked. But one paper—*The Power Engineer*—is going into the subject in some detail, with particular reference to the problems of combined central heating and power stations. The same comment is made by correspondents as has been made here, that the general adoption of central heating might favor more small stations sprinkled through the load, rather than a small number of superstations.

What the Ledger Showed About
Diesel Power Costs

Oil Engines Effect Savings in Refrigerating Service—Power Costs Reduced Sixty Cents per Ton of Ice—No Increase in Labor Charge

By G. GROW



A GOOD illustration of the savings that frequently can be realized through the operation of Diesel engines in an ice plant, is afforded by records of the Arkansas City Ice & Cold Storage Company at Arkansas City, Kansas, which show that Diesel engines reduced the power cost per ton of ice by 60 cents.

When this plant was originally installed about five years ago, oil engines, as well as purchased power were considered, but it was decided to use motor drive throughout the plant and purchase energy from the central station. Factors that influenced this choice of power included statements by ice-machine salesmen that electrical energy at 2 cents per kilowatt-hour was more economical than oil-engine drive.

The plant was operated with purchased energy for four years, but a realization that neighboring plants operating with oil engines were making ice at considerably lower cost than they were, led the owners to start a careful investigation which resulted in the installation of Diesel engines.

Their records showed a consumption of 75 kw.-hr. per ton of ice manufactured. This covered all current used in the plant, including that used by the motors driving the ammonia compressors, the air compressors for air agitation, water pumps, hoists, as well as for car icing, lights, refrigeration for 11,000 tons storage, etc. With the normal output of 15,000 tons for 11 months' operation the total energy used was 1,125,000 kw.-hr., which at $0.014 per kw.-hr. cost $15,750, or $1.05 per ton of ice.

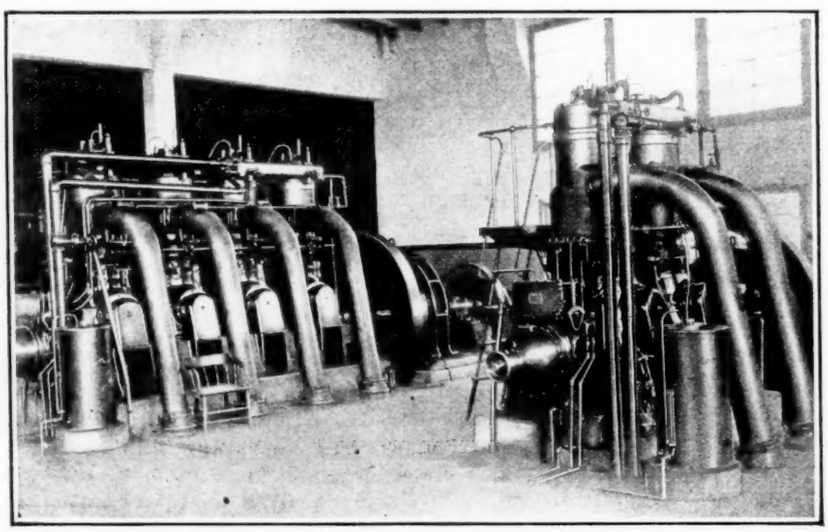
Since all the equipment in the plant was already arranged for motor drive, engines direct connected to alternating-current generators were installed, using two units, one rated at 120 hp. and one at 240 hp.

The engines were guaranteed to operate on a fuel consumption of 0.46 lb. of oil per horsepower-hour at either full or three-quarters load and 0.52 lb. at half load, and to operate for 2,000 rated horsepower-hours on a gallon of lubricating oil. However, for the sake of conservatism, the consumption of fuel oil was calculated on the basis of 0.5 lb. per hp.-hr., although the plant would normally be operating at three-quarters load or above.

The cost of the machinery, installed, was $28,000, and allowing 6 per cent interest on the entire amount, the money actually paid out yearly under the conditions shown is as follows: Interest, 6 per cent on $28,000, $1,680; fuel and lubrication, $5,122; total, $6,802. Deducting $6,802 from $15,750 leaves $8,948 as the saving at the end of the first year's operation which can be applied toward retiring the investment.

No charge has been made for labor, for the reason that there is no additional labor cost. The same men operate the plant with the oil engines that operated it when power was purchased.

This plant has not been in operation a full year yet, so that an actual comparison for a year's operation is not available. However, during the period from Aug. 15, 1925, to March 1, 1926, the plant turned out 525,000 kw.-hr. at a cost of $2,000 for fuel and lubrication, or approximately $0.0038 per kw.-hr., representing a saving of $5,350 for 6½ months, including the lightest period of operation. There has been no repair expense whatever since the plant started, and no interruptions in service. One connecting-rod bearing ran hot shortly after being installed,



A 240-hp. and a 120-hp. Fairbanks Morse Diesel installed in refrigerating plant

due to the lubricating oil tube having been bent out of position, but this involved no repair expense.

On the basis of a year's output of 1,125,000 kw.-hr. at the same cost as for the 6½ months' operation, the operating expense will be as follows: Fuel and lubricating oil, $4,320; interest, 6 per cent on $28,000, $1,680; incidentals, 2 per cent, $560; total, $6,560.

Deducting $6,560 from $15,750 leaves a difference of $9,190, which is available for retiring the investment. At the end of the second year the investment will be reduced to $9,068 and will be completely retired in the third year.

It will be noted that the depreciation item is not included, for the reason that depreciation is in itself a retirement of the investment and so it should not be added as part of the cost of operation when all the savings are applied in estimating the time it will take to retire the capital.

The Slide Rule and the Power Man

By Raymond L. Drew

This is written especially for those power-plant men and mechanical men in general who believe that the slide rule is a useless play-toy, to those who feel that it is a mysterious calculating machine that requires an operator endowed with the magical powers of a wizard, and to those who "just can't get the hang of using it."

I feel quite sure that each of these men has gotten the slide-rule idea sometime during his career, and has probably provided himself with a rule and undertaken to solve his problems by the aid of it. Probably in most cases its use was abandoned very early, because it was found that it could not be manipulated to produce results in multiplication and division as speedily as those results could be obtained by the conventional arithmetical method.

Anyone should be able to follow given settings on the slide rule just as easily as he can follow a formula in a handbook, but in order to solve actual problems, an idea of the basic logarithmic principles upon which the rule is constructed, along with considerable practice, is necessary.

I say considerable practice, for that is the most important thing. In fact it might be truly said that the manipulation of the slide rule is an art rather than a science, and, like all arts, must be practiced to be acquired. One or two trials—even a dozen trials—will not make one proficient with the slide rule.

A fairly good understanding of logarithms and their use would help one considerably to understand the method of the slide rule. Then, too, by starting with simple multiplication problems and doing many of them, always watching the position of the decimal point, one will acquire greater speed and accuracy in readings.

I do not intend to describe the use of the slide rule, for considerable has been written on that subject, but I should like to show that this instrument is well suited to the daily problems of those interested in power-plant work.

Besides the solutions of the specific problem at hand, you get, when the setting is made on the rule, the results that a variation in one or more of the variables would produce. Try this example on your slide rule and you will see what I mean: A pump, equipped with a 24-in. pulley, is to be belted to a lineshaft that is turning 216 r.p.m. The shaft is to be fitted with a pulley that will drive the pump 81 r.p.m. Now, on the rule, set 216 on the D scale to 81 on the C scale and read above 24, 9 on the C scale, which is the proper size of pulley. Now by moving the slide so as to cause 8.5 on the C scale to coincide with 24 on the D scale, you will find 76.5 on C above 216 on D, which of course means that an 8.5-in. pulley on the shaft would drive the pump 76.5 r.p.m. In a like manner if you bring 9.5 to 24 you will find that a 9.5-in. pulley would drive the pump 85.5 r.p.m. The whole situation is in front of you.

Suppose it is necessary that the pump turn exactly 80 r.p.m. and you wish to know the size of standard pulleys that could be used. Set 80 on C over 216 on D and read them off. Under 10 on C read 27 on D. That is 10-in. on the shaft and 27-in. on the pump. Under 5 on C read 13.5 on D, and so on.

Let us consider one more proposition concerning this pump. What is the linear velocity of the belt? Set 80 (the speed of the pump) on the C1 scale over Pi (3.142) on the D scale, and read under any diameter of pump pulley in feet on the C scale, the velocity of the belt on the D scale. Where the rule has no C1 scale, set the index of the C scale over 80 x Pi on the D scale and read velocities on D under diameters on C.

A good many of the handbook formulas that you use every day can be worked out just as conveniently on the slide rule as this pulley problem. When you wish the area of a circle of a given diameter, the pressure in pounds per square inch of a given head of water, the cubes of squares of numbers or their corresponding roots, the reciprocals of numbers and many other functions, one simple setting will suffice. Tables, in books on the slide rule, give many other settings of considerable interest to the power engineer.

At first it is a good plan to work the problem on paper also, to check your slide-rule result, as it will take considerable work on the rule to master all its tricks. Don't give up because you have a lot of trouble at first obtaining a result in a reasonable length of time. Of course it will go slowly at first, and the only way to attain speed and accuracy is by practicing.

Feed Water Series To Start Soon

During July *Power* will start publishing a series of articles broadly covering the whole field of boiler feed-water treatment. The author is Sheppard T. Powell, a prominent consulting chemical engineer, of Baltimore, Maryland. Mr. Powell's long experience and recognized standing in this field will make the feed-water series of such practical value that no operating man can afford to overlook it. This is particularly true since no publisher has yet made available either in book form or in the technical journals, an adequate up-to-date treatment of this important subject in all its practical phases. Mr. Powell has no ax to grind. His sole object is to present all the facts in usable and understandable form.

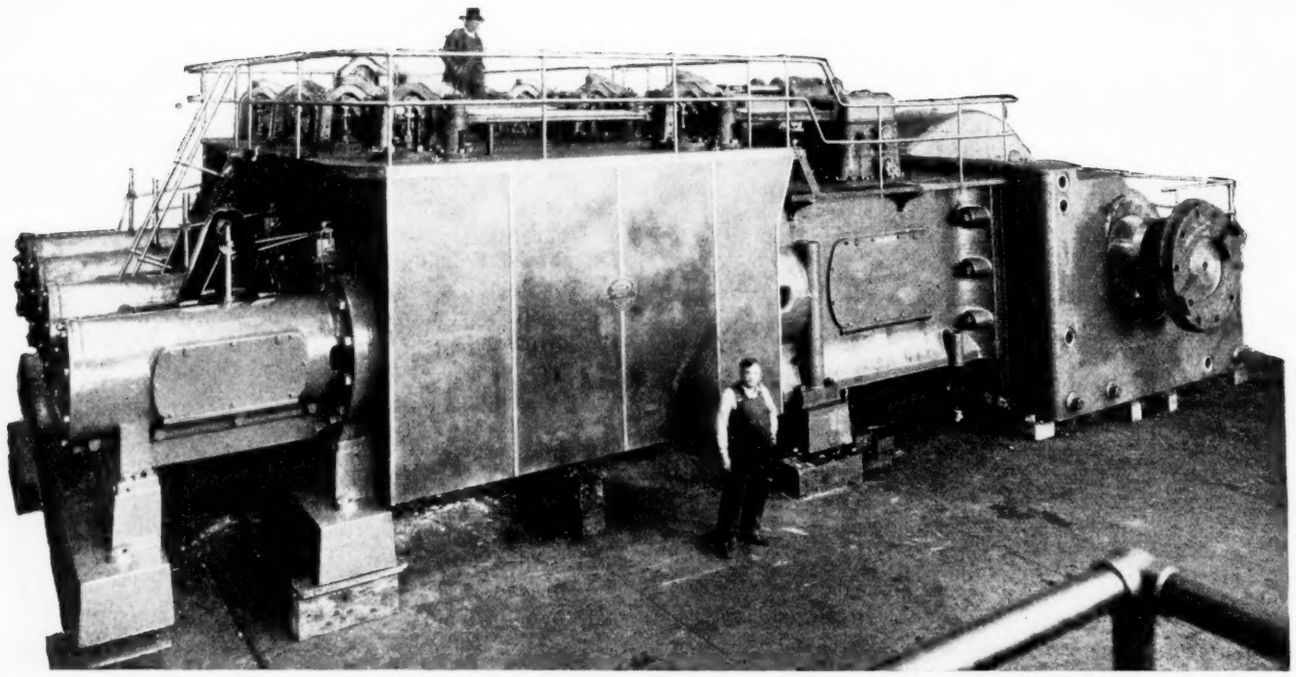


Fig. 1—Reversing uniflow engine having maximum capacity of 30,000 i.hp. at 150 r.p.m.

First and Largest Uniflow Engine on Blooming Mill

BACK in 1923 a shortage of blooming-mill tonnage in the Steubenville rolling mills of the Wheeling Steel Corporation necessitated the installation of a 35-in. two-high blooming mill and a 19-in. continuous bar mill. As is usually the case, the old steel plant did not provide ideal conditions for the new equipment, so it was decided to install as auxiliary to the new mills a modern boiler plant, a power plant consisting of two 1 000-kw. direct-current generators driven by two 24x40-in. duplex condensing uniflow engines, a gas-producer plant and additional soaking pits.

The equipment in the boiler plant consisted of five bent-tube boilers, each containing 8,290 sq.ft. of heating surface and operating under steam conditions of 250 lb. gage and 150 deg. F. superheat. Arrangements had been made to burn in combination blast-furnace gas and powdered coal, the latter being prepared by unit pulverizers. Before the plant had been placed in operation, however, it was found that most of the blast-furnace gas would be needed in another boiler house, so except when a surplus of coke oven gas is available, powdered coal is the only fuel used.

In the plant, generally, there are a number of new features, but the chief interest lies in the selection for the first time of a uniflow engine to drive a blooming mill, and this engine is the largest so far as known, not in cylinder size,[1] but in power that may be developed at maximum cutoff. Previous experience with this type of engine on sheet-mill operations had been most satisfactory, and it was the belief that savings equally large could be made by applying the uniflow principle to the drive for a reversing mill, particularly if the steam were supplied by a modern boiler plant. The progress made by the electrification of this type of mill supplied with power from economical sources helped to confirm the view that a decided improvement in economy could be expected from a condensing uniflow engine over previous wasteful conditions and that the flexibility and simplicity of the steam drive could be retained at a first cost considerably below that of an electrically driven mill.

Uniflow engines, therefore, were the selection of the engineering department of the company, and the problem of supplying them was passed along to the Nordberg Manufacturing Co., of

FOUR-CYLINDER condensing uniflow engines—one on a continuous mill that at 45 per cent cutoff will develop 14,000 i.hp. and a reversing engine having a maximum rating of 30,000 i.hp. Normal capacity is 100 tons of steel per hour, at a steam consumption of 280 lb. per ton of steel, for reversing blooming-mill engine. Per indicated horsepower-hour the continuous and the reversing engine use, respectively, 10.5 and 16.3 lb. of steam.

[1] The largest uniflow engine according to cylinder size so far built is the 60X66-in. duplex rolling mill Nordberg uniflow engine, described in *Power* of July 28, 1925

Milwaukee. Before laying down the design, the builder made a thorough investigation of the possibilities of, first, a compound engine; second, a single-expansion three-cylinder full poppet-valve engine, and third, a four-cylinder uniflow poppet-valve engine. Studies[2] were

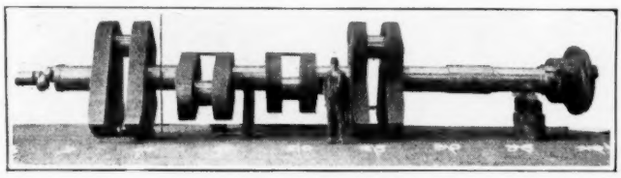


Fig. 2—Main crankshaft with crank at left for driving layshaft

made of the inertia forces and the moments of the reciprocating and rotating parts and also of the fluctuations of torque during one revolution. The combined horizontal as well as the vertical moments of these forces were found to be much smaller on the four-cylinder engine than on either the compound or the three-cylinder engine.

Torque diagrams from two-, three-, and four-crank engines of equal total piston displacement showed that at the coupling end of the crankshaft the average torque of any engine was the same for a given cutoff, but that the maximum torque increased and the minimum available torque decreased, the fewer the number of cranks. A two-crank engine, therefore, required a larger shaft and heavier reciprocating parts than a four-crank engine. It would not start so smoothly nor run so easily when the ingot was approaching the rolls at low speed. It was evident that the rolls would bite better and there would be less slippage during rolling, the more uniform the torque.

From average indicator diagrams of the working strokes it was found that a twin tandem compound engine would produce a fluctuation of torque of 53.2 per cent, while a four-crank uniflow engine showed only 27.5 per cent. Average combined indicator diagrams of a twin tandem compound engine in actual service were compared with an assumed average indicator diagram of a uniflow reversing engine doing the same amount of rolling work under identical steam conditions, 150 lb. initial pressure, and also when steam was supplied at 240 lb. pressure to the uniflow engine. During the working strokes in the compound engine, an average of 66.6 per cent of the available mean effective pressure was realized, while in the uniflow engine this average amounted to 77.5 per cent under the same operating conditions and a percentage of 79.4 was considered conservative for the 240 lb. initial steam pressure.

Other factors pointing to the uniflow engine were the elimination of the receiver loss, utilization to a greater

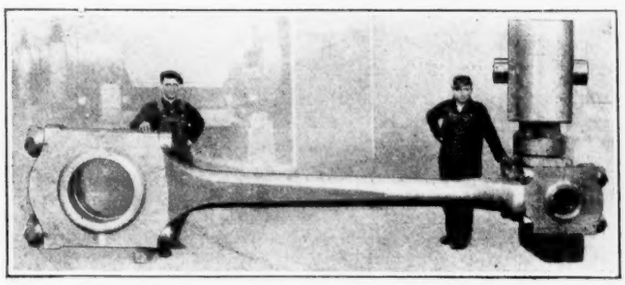


Fig. 3—Connecting rod and crosshead

extent of any degree of vacuum, high and practically uniform economy over a range of load from 25 to 150 per cent, and the use of double-beat balanced poppet valves, which were considered the only valves that could be made tight and remain so against high steam pressure and superheat.

The problem was reduced to the building of a four-cylinder reversing blooming-mill engine of the uniflow type and a duplicate in the form of a continuous-mill engine, with the exception that the latter has a flywheel and the cutoff is controlled by a governor functioning through hydraulic thrust cylinders. Each of these engines has four cylinders 36 in. diameter by 60 in. stroke, operating under steam conditions at the throttle of 240 lb. gage and 125 deg. F. superheat. The continuous-mill engine at 75 r.p.m. and 45 per cent cutoff, will develop 14,000 i.hp., and the reversing engine, on the

[2]These comparisons and data in connection with the installation are presented in fuller detail in a paper read before the Association of Iron & Steel Electrical Engineers in Chicago, June 8, by M. J. Conway, combustion engineer of the Wheeling Steel Corporation at Steubenville, Ohio.

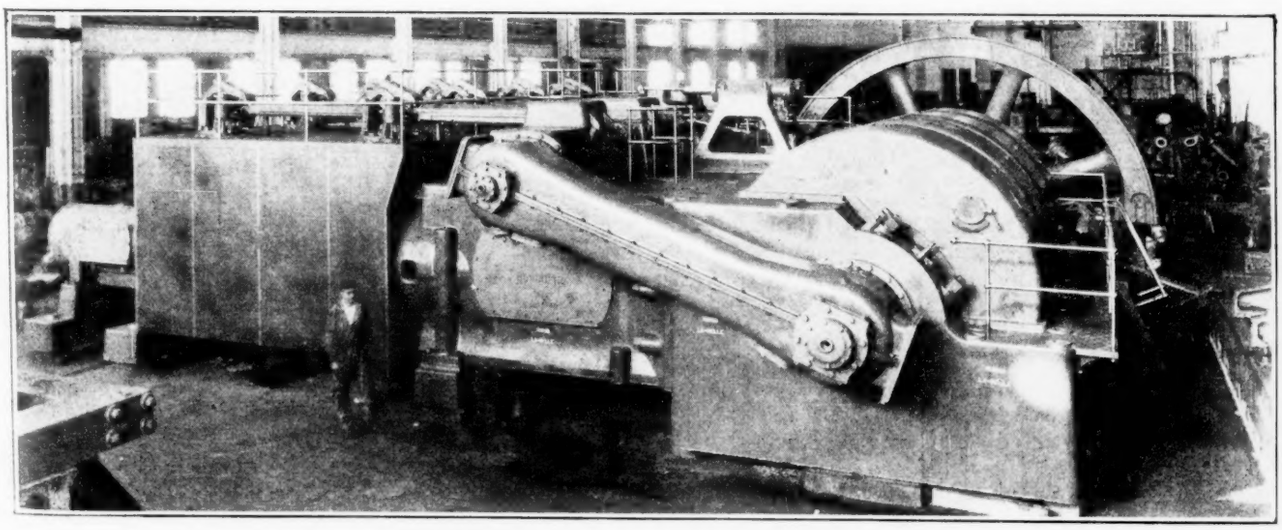


Fig. 4—Continuous-mill engine with layshaft drive in foreground. Maximum rating 14,000 i.hp.

basis of 150 r.p.m., and maximum cutoff, will deliver a maximum of 30,000 i.hp. This, of course, is only momentary, as in the course of operation the engine may be reversed from full forward to full backward as often at twenty times a minute.

Some indication of the enormous size is brought out by the physical data in the accompanying table, giving approximately 1,000,000 lb. as the total weight of either unit, a bedplate weighing from 80 to 120 tons, a crankshaft complete of 80 tons, a cylinder barrel of 13 tons, a connecting rod of 9,500 lb. and the piston with the rod weighing 7,000 lb.

Reference to the illustrations will show the general arrangement of the blooming-mill engine, which, with the exception of the control, is practically a repetition of the continuous-mill engine.

To hold the size of the castings within reasonable limits, the bedplate of the reversing engine was made in three pieces solidly drawn together with links sunk into the walls, this construction eliminating flanges and heavy tierods going through the entire width. Into the frame are fitted five main bearings, each consisting of two circular shells held in position by a cap bolted down against the top shell and shims. The lower shell fitting into the circular recess of the frame, may be rolled out if the pressure on the shaft is relieved.

Forged-steel webs and straight pins pressed together form the built-up crankshaft. The cranks are spaced to give a power impulse every 45 deg., so that maximum torque may be produced at whatever position the engine may stop. The two outer cranks are proportioned to balance the rotative forces and moments of

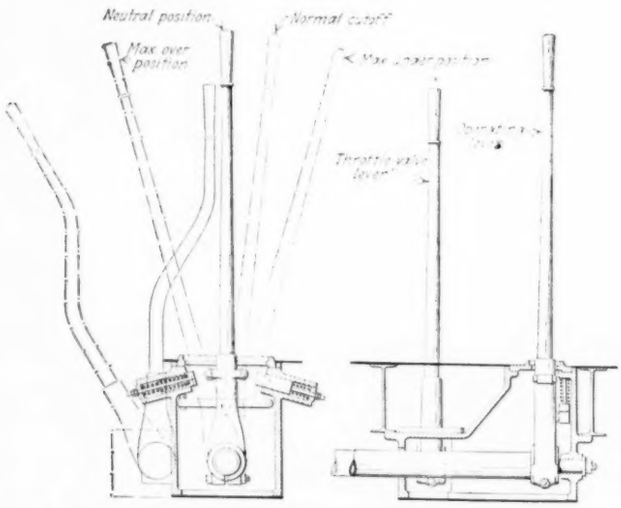


Fig. 5—Operating lever for reversing engine

the entire unit. The connecting rod is a hollow steel forging of the forked marine type, and the wristpins are a part of the forged crosshead body to which the shoes are bolted. The piston rod is keyed to the crosshead, extends through the back cylinder head and is supported at the rear end by a turned tail guide shoe. The piston is of the full floating type fitted with snap rings and steamtight keepers.

The cylinder proper consists of one principal casting to which is bolted the steam chests containing the steam valves, their removable cages and bonnets, the relief and auxiliary exhaust valves. Midway of the length of the cylinder are the uniflow exhaust ports, which are uncovered by the piston at the end of each stroke and discharge into a belt surrounding the cylinder leading into a common exhaust manifold.

Operation of the main steam valves is effected from the main crankshaft through a five-throw crank on the end opposite from the mill side, which, by means of parallel rods, drives an identical five-throw crank on the layshaft, the latter running across the whole width of the engine in bearings mounted on top of the crosshead

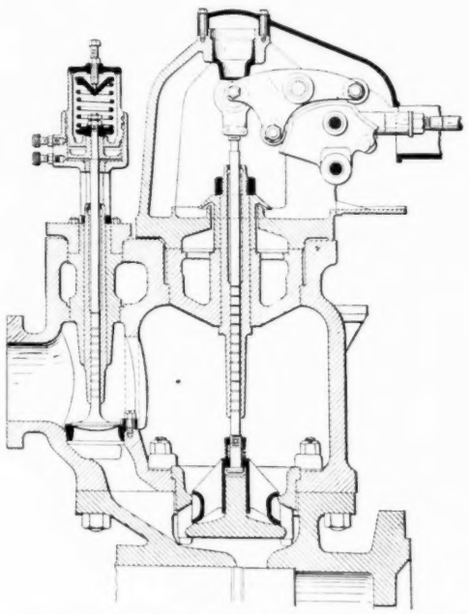


Fig. 6—Section through main steam and relief valve

slides. Eccentrics forged integral with this layshaft, one for each cylinder end, operate oscillating cams which positively open and close the double-beat, balanced poppet valves controlling the entrance of steam to the cylinder.

This valve is shown in section in Fig. 6. It will be seen that the stem is connected flexibly to the valve proper by means of a spring and that grooves are cut on the stem to form a labyrinth packing to prevent steam leakage. A relief valve has been provided at the main steam admission. Should the steam pressure in the cylinder rise beyond that in the steam chest, the differential will automatically lift this valve and allow the steam trapped in the cylinder to flow back into the steam pipe, thus providing against any overcompression that otherwise might take place.

Operation of the engine is effected by a single lever control, Fig. 5, the manipulation of which reverses the engine, changes the cutoff and operates the throttle valve. An auxiliary lever has been provided to re-open the safety stop valve should the safety stop function. With the operating lever in the vertical position the reversing mechanism is neutral, with all the steam valves and the throttle closed. Moving the lever forward or backward throws the valve gear in the running over or under position and opens the throttle valve, the length of the cutoff being proportioned to the throw of the lever. At normal cutoff the lever is pushed against a spring stop, which does not prevent the lever from being moved to the extreme position, but will always bring it back to the normal cutoff.

Should the engine stall, a small auxiliary exhaust

valve, attached to the valve chest in much the same way as the relief valve, is automatically brought into operation. Moving the operating lever beyond its normal cutoff position gives a greater swing to the steam cam, so that it presses down on the stem of the auxiliary exhaust valve and by reducing the compression, increases the effective pressure in the cylinder. Thus the engine may be made to exert more torque or reverse quickly under unfavorable conditions by the manipulation of a single operating lever beyond the points of normal cutoff.

Through crossshafts and a system of floating levers the control lever actuates operating valves controlling the oil to the reversing and throttle-operating cylinders. These two double-acting hydraulic thrust cylinders are located side by side on top of the bedplate and are operated by oil under pressure, furnished by motor-driven pumps and stored in accumulators. Oil is admitted to and exhausted from the thrust cylinders by balanced poppet-type hydraulic valves, so arranged that it is impossible for the inlet and outlet valves to open at the same time. The movement of these valves, and therefore that of the thrust cylinders, follows closely the motion of the operating lever, and whenever the operating lever comes to rest, the thrust cylinder does likewise and is securely locked in that position, because both of the hydraulic valves are closed.

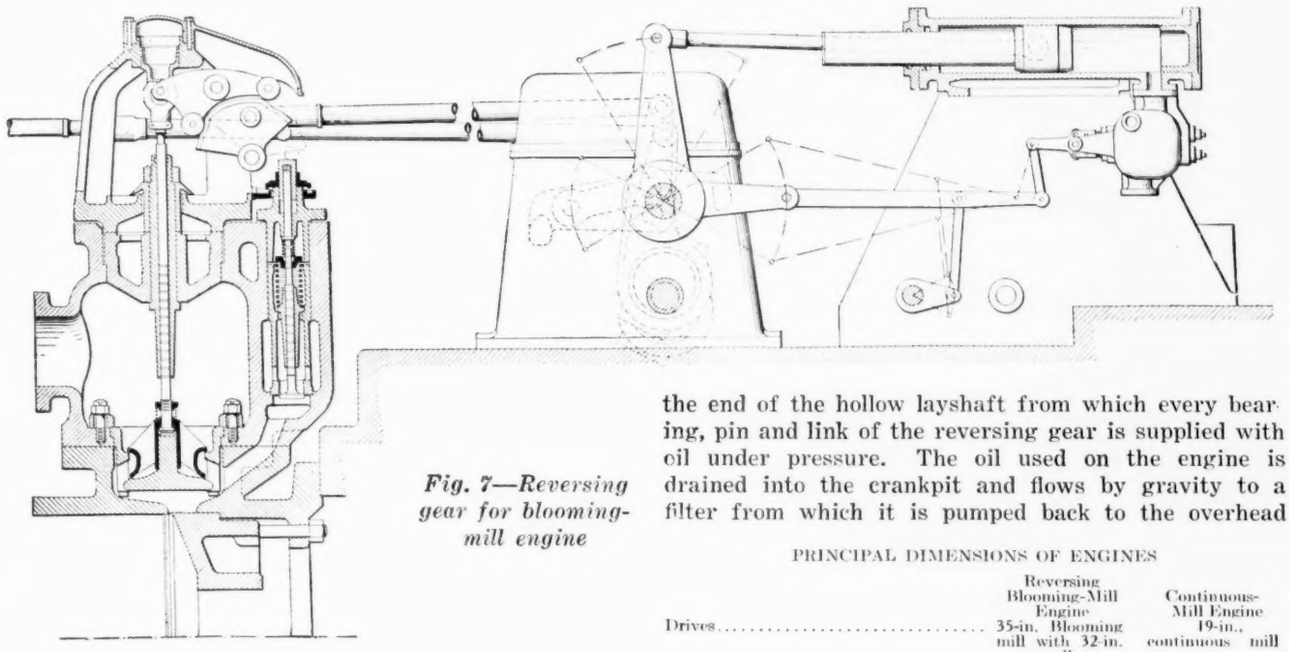


Fig. 7—Reversing gear for blooming-mill engine

Fig. 7 shows the reversing valve gear, which is of the Marshall type, having one link mechanism for each end of a cylinder. This gear is designed to give correct steam distribution with sharp cutoff for each end of the cylinder throughout the entire range of operation. Thus the length of the steam admission is controlled by the operator's lever and the engine is run entirely on the cutoff. The engine is protected, however, against overspeed by an overspeed governor and a safety stop. When the engine is running at 150 r.p.m., the overspeed governor rings a bell, and at 160 r.p.m. closes the throttle valve. By pulling the throttle lever back, the operator opens the throttle valve again and resets the governor. At 170 r.p.m. the safety stop, located under the throttle valve, closes and has to be reset by the engineer. This stop can be tripped from several stations in the engine room and on the pulpit, if it should be necessary to close down the engine quickly.

The throttle, which is at the back end between the two middle cylinders, like the steam valves, is of the double-beat balanced poppet-valve type, positively opened and closed by a cam actuated from the reversing gear mechanism. From the throttle valve the steam reaches the different cylinders through horizontal steam pipes fitted with expansion joints.

A forced-feed system of lubrication has been provided through which all the running parts of the engine are supplied with oil under pressure from a large overhead tank. The oil is introduced in the end of the hollow crankshaft, flows through the drillings into circular grooves in the main bearings and crankpin shells and reaches the wristpins and crosshead shoes through the hollow connecting rods. A second oil line connects to the end of the hollow layshaft from which every bearing, pin and link of the reversing gear is supplied with oil under pressure. The oil used on the engine is drained into the crankpit and flows by gravity to a filter from which it is pumped back to the overhead tank. It may be of interest to record that with this simple but effective oiling system in use, it has not been necessary to take up on the main bearings, crankpin, wristpins or crosshead shoes since the engine was placed in operation.

PRINCIPAL DIMENSIONS OF ENGINES

	Reversing Blooming-Mill Engine	Continuous-Mill Engine
Drives	35-in. Blooming mill with 32-in. rolls	19-in., continuous mill
Engine cylinders, four, diam. x stroke, in.	36x60	36x60
Steam pressure, lb. gage	240	240
Superheat, deg. F	125	125
Vacuum, in. abs.	4	4
Speed, r.p.m., normal max.	150	75
Main bearings, five, diam. x length, in.	22x28	22x28
Outboard bearing, diam. x length, in.	.....	23x36
Crankpins, diam. x length, in.	21x16	21x16
Crosshead pins, two per cyl., diam. x length, in.	9x8¾	9x8¾
Crosshead shoes, width x length, in.	20x33	20x33
Tail-guide shoes, width x length, in.	18x21	18x21
Piston rods, hollow, diam., in.	10	10
Steam pipe, diam., in.	14	14
Exhaust pipe, diam., in.	20	20
Wrights in Pounds		
Engine complete	950,000	1,000,000
Main bedplate	240,000 (3 pieces)	160,000 (1 piece)
Crankshaft, complete	160,000	165,000
Crosshead slides, each	37,000	37,000
Tail guides, each	8,500	8,500
Cylinder barrels, each	26,000	26,000
Cylinder heads, each	2,000	2,000
Piston and hollow piston rod	7,000	7,000
Crossheads, each	3,000	3,000
Connecting rods, hollow, each	9,500	9,500
Flywheel, 20 ft. diam., in four sections, complete	.....	75,000

With the continuous-mill engine, control is effected by a governor of the centrifugal type, which, functioning through the oil thrust cylinders, regulates the cutoff of the steam. While both relief and auxiliary exhaust valves are provided in the case of the reversing engine, the relief valves only are used in the continuous-mill engine.

Both engines operate on a vacuum approximately within 4 in. of absolute. The condenser, shown in section in Fig. 8, differs somewhat from the usual steel-plant design. To conform to existing conditions it was designed to take care of large pulsations of steam and still maintain a satisfactory vacuum with a constant flow of water. This condenser, which operates on the barometric principle, is built up of a large cast-iron shell about 10 ft. diameter and 24 ft. long, inside of which are a number of horizontal trays placed one over the other. Through holes in these trays and notched overflows at the ends of the trays, the water passes downward from one tray to the other, so that in its four passes through the condenser the steam must come into intimate contact with the finely divided water. By this arrangement considerable water is held in storage, so that ample surface and volume are provided to take care of the sudden fluctuations in the volume of the steam coming to the condenser.

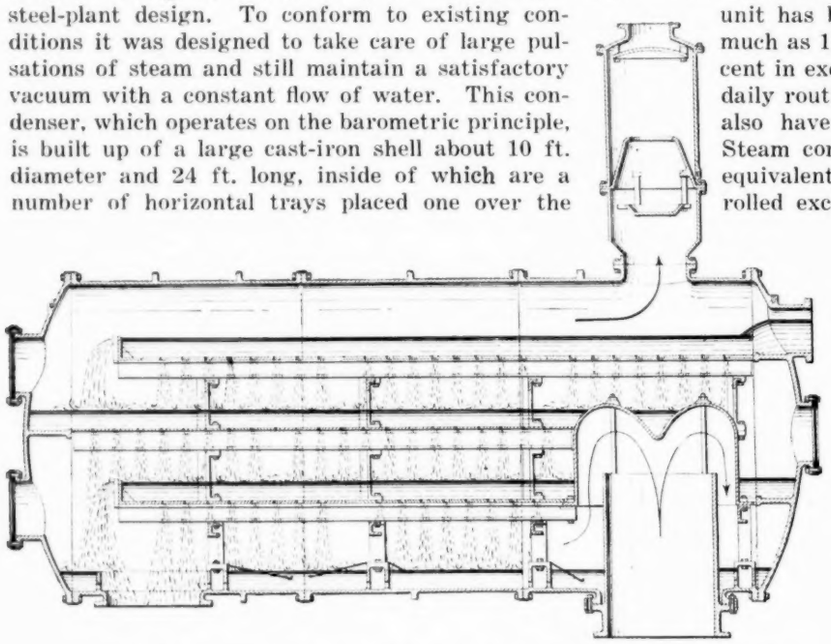


Fig. 8—Barometric condenser used for rolling-mill engines

There are three of these condensers, one for each rolling-mill engine and one to serve the two generating units. The vacuum pumps are of uniflow design having suction ports and spring discharge valves. They are all of the same size and type and are driven by ordinary piston-valve steam engines, the speed being controlled by throttling governors.

For some time after the engines were installed a number of operating difficulties developed that retarded production until corrected. The initial cause for most of these troubles was an excessive quantity of foreign matter carried over with the steam right after the new boiler plant had been placed in operation. Since the necessary repairs have been made and purifiers installed in the boilers to insure clean steam, the engines have been operating to the entire satisfaction of all concerned.

Careful estimates by the builder under steam conditions of 240 lb. pressure, 125 deg. F. superheat, and 26 in. vacuum, have placed the total steam consumption of the reversing blooming-mill engine and its air pump at approximately 280 lb. per net ton of steel rolled, this being obtained when reducing an 8,300-lb., 19x 26-in. ingot to 11 elongations and rolling at the rate of 100 net tons per hour. Steam consumed per indicated horsepower-hour of the main engine was placed at 16.3 lb., including an allowance of 44 per cent, of which 15 per cent was for plugging and 29 per cent for throttling. Without these allowances the steam consumption of the continuous-mill engine should approximate **10.5 lb. per i.hp.-hr.**

In service the great flexibility of the steam driving unit has been demonstrated by the rolling of as much as 165 tons of steel an hour, which is 65 per cent in excess of the normal capacity. During the daily routine of the plant certain commercial tests also have served to check the steam economy. Steam conditions were not quite normal, but the equivalent steam consumption per net ton of steel rolled exceeded the estimated figure by about 10 per cent. In actual operation, the size of the sheet bar ingots had been increased to 22x24 in., weighing 9,300 lb., and the test referred to was run at a rate of 133 net tons of steel rolled per hour, which is 33 per cent in excess of the normal rate for which the engine was designed.

It is to be observed that the steam measurements were made by flow meters which may not have been entirely accurate, owing to the fluctuating steam flow, and in addition no special care was taken by the daily operator to economize steam in handling the rolls. Under more perfect conditions of steam measurement and of operation, it is likely that the foregoing estimate could be closely approximated in service.

Termofones

The power plant of the future may come to resemble Main Street on the Fourth of July if a little device recently tested at the Mellon Institute for the American Refractories Institute finds application in the power field.

It is called a "termofone" and consists of a cylinder $\frac{3}{4}$ in. in diameter and 1 in. long, made of clay material, in the center of which is embedded a small metal container inclosing an explosive. One of these termofones is thrown into the furnace and after a time the heat detonates the explosive, shattering the clay cylinder with a noticeable report. The higher the temperature of the furnace being tested, the shorter will be the time interval necessary to detonate the cap. It is this time interval which is used as an index for the furnace temperature.

The termofones are made in Germany and are supplied in boxes of fifty with a calibration table. The test showed the termofones to be considerably in error, the average error being about 400 deg. F. This was admitted to be so great as to make them practically useless for control purposes, but it was suggested that improvements might make them of practical value.

Fundamentally, there would seem to be two requirements for accuracy—an explosive material detonating at a definite temperature and a surrounding medium of fixed heat conductivity and heat capacity. Obviously, the materials must also be cheap.

Why Not Overhaul the Pumps?

UNLIKE most commodities the manufacturing cost of ice is made up almost exclusively of the engine-room expense. For this reason refrigerating engineers keep the compressors and driving engines in better shape than is usual in many power plants. Still, it is questionable if many, in their attention to the compressor, give the condensing water pumps the care needed. As to the mechanical condition of these pumps little fault can be found, but in the scheme of operation there is a large opportunity for improvement.

A reduction of but one pound in the condenser pressure is visibly reflected in the lower total power curves of the plant, and to hold the pressure at the minimum calls for water and plenty of it. True, it costs money to place water over or through a condenser, but the reduction in compression power far offsets the increase in pumping power. The extreme is, of course, to be avoided, for little benefit is derived from water that splashes off the top tube and fails to reach the sump without an increase of temperature. Nor is it necessary at half-load to pump the full-load water requirement. Each plant is an individual problem and the operating engineer is the most logical person to correct defects in the pumping end of the plant.

Measurement of Furnace Temperatures

IT IS frequently desirable to attempt to measure furnace temperatures. The instruments available for this purpose are thermocouples, optical pyrometers and radiation pyrometers, as well as the older methods of using Seger cones.

Thermocouples must be of platinum and platinum-iridium or similar type, and if the furnace temperature is high, their readings are open to some doubt. Furthermore, they must be protected from the flame by porcelain or other tubes. Also, the mass of the thermocouples must be small, and hence only small wires can be used.

Optical and radiation pyrometers are liable to considerable error, for they tend to indicate the temperature of the object seen by them rather than the flame temperature itself. In the case of the optical pyrometers, the color of the flame is matched against the color of a filament in a small electric lamp; that is, the incandescence in the two cases matches. When the flame consists of a dense glowing mass full of burning carbon particles, the incandescence of these particles is probably a fair measure of furnace temperature and can be determined by an optical pyrometer.

Suppose, however, that a gas high in hydrogen is burned after mixing thoroughly with highly preheated air before it enters the furnace. The flame may be colorless and quite transparent. An optical pyrometer would then see the walls opposite it. If these are of firebrick, the whole furnace will approach black body conditions and the reflected radiations from such a wall will be a fair measure of actual furnace temperature. If these brick walls are cooled or if water-cooled metal walls are used, it will at once be apparent that an optical pyrometer would probably read too low when sighted into a furnace with colorless flame, for the observer would be matching the glow of the filament with that of the opposite wall. The optical pyrometer will tend to read low for all flames between the glowing and the transparent conditions.

Radiation pyrometers measure the intensity of rays of all wave lengths of both light and heat. The readings are affected by smoke and dust. Carbon dioxide and water vapor will absorb radiant heat waves. Hence, if the radiation pyrometer is sighted through the cooler layer of these gases that is on the outside of many water-cooled furnaces, the gases will screen off certain of the rays from the center of the furnace and the observed readings will be too low. One cannot easily tell when this is taking place. Hence, radiation thermometers are also liable to read too low.

These comments will emphasize the liability to error in furnace-temperature measurement and the necessity of great precautions to secure correct temperatures. The effect of cold walls on furnace observations has not been carefully noted on certain recent tests, and misleading conclusions have been drawn from incorrectly measured furnace temperatures.

The matter warrants research and careful analysis.

Valve Standardization

ON ANOTHER page of this issue the dimensional standardization of pipe joints and fittings is discussed. The most serious aspect of this matter is perhaps in connection with valves.

Until very recently there has been a great variation among manufacturers in the design and dimensions of the more common types of flanged valves such as gates, globes and checks, for all pressures. The differences in face-to-face length were due to the lack of a national standard covering this point, although a few manufacturers have adopted substantially the same lengths for certain lines of valves. When the A.E.S.C. Steel Flanged Standards were worked out, it was agreed to cover this point by making the valve lengths the same as those of tees, crosses, etc., in each standard except 250 pounds W.S.P. The fact that each manufacturer already had a line of patterns for different length valves suitable for 250 pounds pressure, prevented an agreement on any one set of dimensions which the other manufacturers were willing to change to. No national standard has been adopted as yet for the length of 125-pound standard flanged valves, but several manufacturers are making valves to a common set of dimensions which it is hoped will become standard in time.

The variation in valve lengths among different makes in the past has been a source of great annoyance to engineers and power-plant operators. In the first place the drafting department was unable to detail the piping until a selection of valves had been made. In a large job such a selection would not be made until prices and valve designs had been compared. As the prices quoted would depend to a considerable extent on the number of valves of each size required, it is desirable to have piping layouts made up for estimating valve quantities in advance of sending out inquiries. Obviously, a drawing that is made up by guessing at an important detail such as valve lengths, will have to be made over when the correct lengths are available.

Another feature which is objectionable from both a purchasing and an operating viewpoint, is the necessity of buying the same make of valve for use in an addition to the plant in order to maintain interchangeability. There is frequently objection to repeating on the same make either because it has not given the satisfactory performance expected or because the price is not in line on a repeat order. If it is decided to buy another make of valve regardless of the difference in length, it is then necessary to carry two kinds of spare valves of each size in stock for maintenance purposes. The lack of standardization in length still exists with the 125 and 250 pound flanged valves, and it is up to the manufacturers to take effective steps to correct this condition at an early date. The Manufacturer's Standardization Society of the Valve and Fittings Industry has accomplished excellent results in securing co-operation in standardization among the manufacturers, and it is to be hoped that this co-operation will be continued to include standard lengths for these lower pressure valves also.

A feature that has accompanied the standardization of valve lengths has been the practically universal adoption in valve construction of several desirable design features. Among these might be mentioned the use of a cylindrical neck on gate valves, which tends to equalize expansion stresses; the use of a circular bonnet, which permits the use of a recessed circular bonnet-flange gasket; and the provision of six drip or bypass pads symmetrically located on the body.

Side Lights on Recorders

WHY a recording instrument? The common answer is that the recording feature gives one a permanent record of what *happened*. Note the past tense; it shows that the significance of the recorder is not fully grasped. The value of the record in running down the list of yesterday's achievements and failures is equalized—perhaps exceeded—by its momentary usefulness in signaling trends. An indicating instrument may show that the pressure is two hundred pounds. The recording instrument tells this, and the important additional facts that it was one hundred ninety-five pounds a moment ago, and is headed straight for the popping point of the safety valve. In short, a single glance at the recorder tells one something about the future, as well as the present and past.

In almost every field the trend—its direction and rate of change—is as important as the amount. The manager of a business is not satisfied to know that the total sales or net profits for the month are so much. He wants to know whether they are increasing or decreasing. Business may be very good, but a slight downward trend results in immediate action to forestall future losses. It is much the same with CO_2, flue temperature, etc. The momentary reading may be good, but a warning sounded by an unfavorable trend of the curve leads the operator to attend to his fires before holes and leaks have brought efficiency and capacity to a low level.

All this has a bearing on the proper location of the recording instrument, or the recording element in cases where this is separate from the indicator. Very often the recorders are placed in the main office for the sole benefit of the chief engineer. Yet, if a choice of location must be made, will they not yield bigger dividends in the form of improved performance if placed where they can be seen at all times by the men who are operating the boilers or other apparatus concerned—the men who are in a position to take the momentary actions necessary to correct unfavorable trends as they develop? There will still be opportunity for the chief engineer to make a critical study of yesterday's charts. In some cases it will also pay to install an additional recording element in the chief engineer's office to keep him more immediately in touch with what is going on, but it would seem that in any case the man on the job should be given the full benefit of what the instrument can do to help him in his work.

Carelessness Around Pulverized Coal Plants

ALTHOUGH explosions in pulverized-coal preparation plants or in plants where pulverized coal is burned are becoming less frequent and may be said to be rare, occasionally one occurs and serves as a reminder of the inherent dangers in plants of this kind. With few exceptions the causes for the explosions have been traced to carelessness on the part of the operating force rather than to faulty design of the equipment.

That there have not been more explosions is somewhat surprising, in view of the careless operating practices in some plants. It is not difficult to find preparation plants where large "No smoking" signs are prominently displayed in all parts of the building, yet the foreman as well as a number of his staff enjoy their smokes with perfect freedom. Again in some plants copies of the "Regulations for the Installation and Operation of Pulverized Fuel Systems" adopted by the National Fire Protection Association are posted for the guidance of operators, only a few of which are observed.

While the possibility of an explosion in a modern installation is remote, a dangerous condition can suddenly be brought about through carelessness on the part of the operator in attempting to repair certain equipment without properly isolating it from the system, or in removing doors from conveyors while in operation or from bins to which the coal is being fed. Another contributing cause is ignorance of the characteristics of the fuel. In view of this it would seem that too much attention cannot be given to acquaint the operators thoroughly with all the facts before charging them with the responsibility of operating the plant.

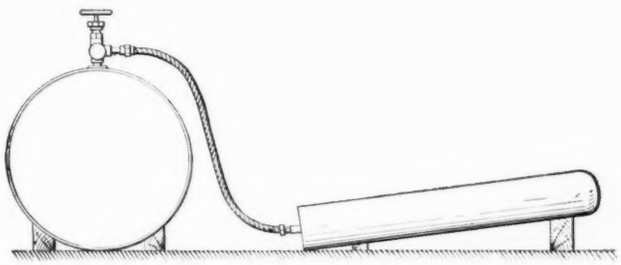
Since pulverized coal in bulk is not explosive but is dangerous only when stirred up into a cloud with the proper proportion of air and brought into contact with an open flame or with a body having a temperature high enough to ignite it, the obvious remedy for danger is good housekeeping and a well-trained staff of operators.

Practical Ideas From Practical Men

Metallic Hose for Charging Ammonia System

Flexible metallic hose with soldered pipe fittings, a nipple and union provides a handy and inexpensive outfit for use in charging the ammonia system, but care must be used to keep down excessive pressure on the hose unless it is designed for high pressures.

Last year we used a 5-ft. piece of ¾-in. hose with entire satisfaction, but let it rust during the winter and had to discard it. Our new hose is of metallic spiral



How the flexible metallic hose was used

construction with a metallic loom covering, which is also soldered to the pipe fittings. The strongest hose our supply house carried was for pressures up to 100 lb., but we feel that we are using it with a wide margin of safety, by reason of our method of charging. We tried the flexible hose because the floor at one of our plants vibrates quite a bit and the drums would crawl and cause a rigid pipe-and-flange connection to leak while we were charging.

Our procedure with the flexible hose is to bring in the full drum and place it near the receiver. There is a nipple on one end of our hose, and this is screwed into the drum connection. On the other end of the hose is half of a union; the other half is on a nipple at the charging valve. The union is connected and the master valve on the receiver closed. With the machine running and the master valve closed, the pressure on our charging valve is about 15 lb. gage. We crack and then open slowly the charging valve to ascertain whether there is a leak in our connections to the drum. If there is no ammonia smell, we open wide the valves next to the expansion coils or tube-and-shell cooler. A glance at our suction gage tells us what the pressure on our flexible tube is. We slowly open the valve on the drum, and as the liquid begins flowing and boiling the hose will frost over. We continue opening the valve on the drum until the frost disappears between the drum and charging valve and we can feel the liquid flowing through the hose.

When the drum is nearly empty, the hose will frost over and almost stop quivering. When the frost melts and no motion can be felt in the hose, the drum is empty. We close the charging valve and carefully break the union to see that no ammonia is left in the drum and then close the valve on the drum. After the expansion valves are set at about their usual opening, we open the master valve and the job is over, except greasing the hose and hanging it up and wiping off that broad smile.

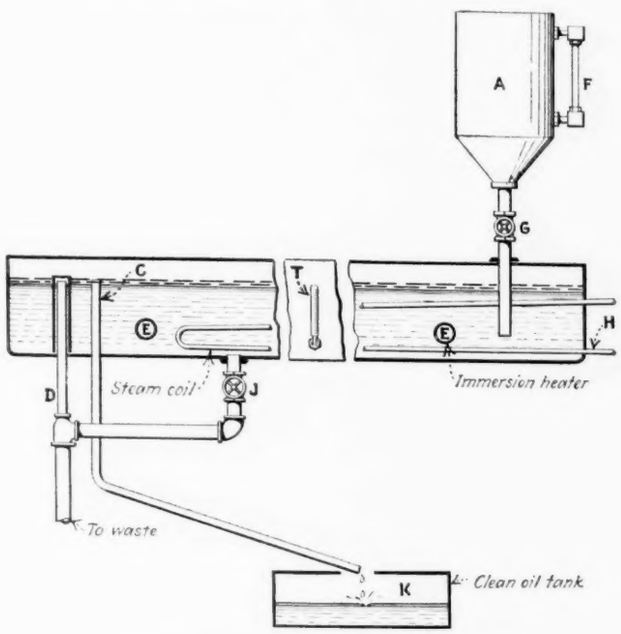
JARRETT LAW.

Harriman, Tenn.

A Simple and Efficient Oil Filter

The accompanying illustration shows an improvised filter for reclaiming lubricating oil used on Diesel engines, which has given good results. Importance need not be attached to the dimensions of the various parts, which were selected from our scrap bins.

The trough is 9 ft. long, 14 in. wide and 10 in. deep and made of No. 20 gage galvanized iron. About 6 in. from one end two ¾-in. pipes *D* and *C*, 3 in. apart, rise up from the bottom of the trough. *D*, the overflow pipe, is 8 in. high, while the height of the filtered oil pipe *C* is 8¼ in. A larger size pipe, preferably 1- or 1¼-in., and longer than *D*, is slipped over it to prevent



Arrangement of improvised oil filter

the oil film flowing down the waste pipe. A valve *J* is connected with an elbow and tee to the overflow pipe and is used merely as a drain when cleaning out the tank.

Two 500-watt 110-volt immersion heaters are inserted in the tank at *E* for use during the summer months, while a steam coil *H* is used during the winter months, using low-pressure steam from the steam-heating system in the power station.

The filter is used in conjunction with one 200- and

one 250-b.hp. air-injection 4-stroke-cycle Diesel engines. Dirty oil from the crankpit sump is pumped into an overhead tank *A* holding about 5 gal., fitted with a fine strainer, a gage glass *F* and a valve *G*. Dirty oil is allowed to pass into the trough at the rate of about 1½ to 2 gal. per hour. The trough is filled with water up to the overflow *D* and kept at a temperature between 130 and 140 deg. F. either by the immersion heaters or the steam coil. A film of oil approximately ¼ in. deep flowing over the hot water, deposits practically all solids and leaves the oil in the clean oil tank *K* ready for immediate use.

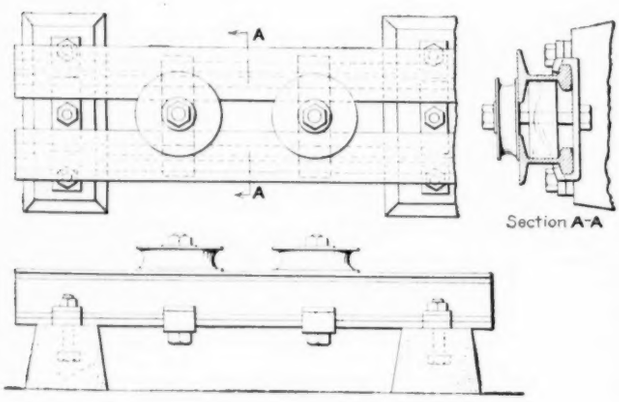
One engine has run a total of 11,760 hours in two years with only one 0.002-in. shim being taken out from one connecting-rod bottom-end bearing. The other engine was new last fall and has run approximately 2,000 hours and no adjustments have yet been made. The makeup oil is put into the main bearings (ring lubricated) and allowed to overflow into the crankpit. All air-compressor pistons, both high- and low-stage, and also main pistons use the filtered oil. The trough is cleaned out once a month and about 20 gal. of slug is removed. The cost of the whole apparatus amounted to about $35. JAMES M. BLOOMFIELD.

Kamsack, Sask., Canada.

Improvised Pipe Bending Table

The illustration shows a practical bending table for pipefitters' or blacksmiths' use. It is made up from pieces of material that can be picked from most any scrap heap.

Two 60- or 80-lb. rails about 12 ft. long are leveled up and grouted into two concrete blocks with ⅞-in.



Pipe-bending table

anchor bolts. The rails are placed upside down so as to make a leveling table for work. The ends of the rails should be cut square to facilitate squaring up bends, etc. A few old cast-iron sheaves of different diameters are used and are so mounted on the rails that they are interchangeable and can be moved to different positions as required by simply loosening the bolts and sliding them backward or forward. A hardwood block is used between the rails for a distance piece and to hold the bolt in place.

This table will prove a practical tool around any small plant or blacksmith shop for bending small pipe from ¼ to 2 in. diameter or for bending round iron.

Port au Port, Newfoundland. R. J. WALSH.

Error in Sampling Boiler Water

Samples of boiler water for chemical analysis are usually taken from the blowoff line leading from the mud drum of the boiler, through a quarter-inch offset tap between the mud drum and the first blow-down valve. Often, where no sampling connection is located on the blowoff line, the samples are drawn from the gage glass on the water column, after thoroughly blowing the column down.

Of course the water in the boiler is under high pressure and temperature, and when it is drawn into the sampling vessel, it drops to atmospheric pressure and lower temperature. The valve on the sampling line is barely cracked open to avoid strong blowing of steam and hot water. On sight it appears that, instead of getting water, most of the sample goes off as steam, leaving very little water. It was all water in the boiler, but in the reduction of pressure and temperature, much of the water is rapidly transformed into steam.

The evaporation of some of the water in sampling introduces an appreciable error in the final sample, rendering it more concentrated than the water in the boiler. This error can be calculated.

The water in a boiler that is under 175 lb. gage pressure, for example, has a temperature of 377.5 deg. F., as obtained from steam tables. Its total heat content above 32 deg. F. is 350.3 B.t.u. per lb. When the water reaches the sampling dipper, it has, being at atmospheric pressure, a temperature of 212 deg. F. and a heat content of 180 B.t.u. per lb. above 32 deg. F.

The loss in heat is 350.3 — 180 = 170.3 B.t.u. per lb. It takes 970.4 B.t.u. to evaporate one pound of water at atmospheric pressure and 212 deg. F. temperature. To supply this heat would require 970.4 ÷ 170.3 = 5.69 lb. of boiler water.

In other words, 5.69 lb. of water would evaporate one pound of water, or 6.69 lb. of water in the boiler would become 5.69 lb. in the dipper. Then the loss would be 1 ÷ 6.69 = 0.15 = .15 per cent.

Since the dissolved substances would remain in the final liquid, the analysis would have to be reduced 15 per cent to give the composition in the boiler.

Where all the samples are taken in the same manner, with the same error in each, the results will be relatively correct. That is, the various boiler analyses will be comparable on the same basis, and the degree of concentration obtained in the different samples will show true relative condition, so that the error can be neglected. These results, however, cannot be compared with the analysis of the feed water, as sampled from the heater, or the raw water that is sampled cold.

To avoid this error or its correction, the samples could be drawn through a condenser that will collect the entire water. For this purpose a jacketed condenser with running cold water could be used, or where samples are taken intermittently, a small coil in a bucket of cold water would be useful. This bucket coil could be made portable and connected to the various boilers successively as samples are taken. This would save the necessity of connecting up fixed condensers to all boilers.

Where the operation is uniform, with no great variation in steam pressure, etc., a standard correction could be applied to all boilers, thus avoiding the inconvenience of condensers. J. S. KUNZ.

Pittsburgh, Pa.

Comments from Readers

Overcoming Slush-Ice Troubles

With reference to the letter from John J. Williams, in *Power* for April 13, asking for suggestions for dealing with slush ice, experience has shown that the best preventive of slush ice or frazil ice is a large body of still water above the intake. This quickly freezes over and any frazil ice carried down from swift water above either adheres to this ice sheet or melts before reaching the racks.

A good arrangement to avoid ice trouble is to place the racks as far below the surface as possible and keep the velocity of the water low as it enters the racks. The ice, being lighter than water, tends to stay on the surface, if not drawn down by the velocity of the water. Also, the temperature of smoothly flowing water increases slightly with depth.

The foregoing preventive measures may not be applicable to a plant already in operation, although they should be given serious consideration. What is sometimes done is to raise the racks part way and let the ice go through the turbine. If the turbine can be kept in operation at full gate the ice might go through. There are plants being successfully operated in this way. The question is, In the particular case under consideration, will a head of 12 ft. be sufficient to force the ice through the turbine? In some cases of this sort the trouble has been overcome by heating the turbine by means of electric energy.

In Norway electric heating of the racks has been resorted to with considerable success. It has been found that an energy consumption of from 0.14 to 0.28 kw. per cu.ft. per second would keep the racks free from ice. In the case under consideration this would amount to from 35 to 70 kw. This heat should be applied directly by passing the current through the rack bars.

Shawinigan Falls, Quebec. C. R. REID,
Power House Superintendent,
Shawinigan Water & Power Co.

Losses Due to Boiler Scale

The editorial in the Feb. 2 issue on "Boiler Scale" prompts me to record some of my experience, which would seem to bear out some of the views expressed in the editorial. The water used for boiler feed in our plant contains a considerable percentage of solids as shown by the following table:

ANALYSIS OF BOILER FEED WATER

Substance	Grains per U. S. Gallon
Sodium chloride	1.15
Calcium sulphate	5.73
Calcium carbonate	9.61
Magnesium carbonate	7.71
Silica	.40
Iron oxide and alumina	.17
Total solids	24.77

From the analysis it will be apparent that considerable scale would form in the boiler if some means were not provided to remove the impurities before the water entered the boiler.

For some time I have been of the opinion that the loss due to various thicknesses of scale as given in the old handbooks was misleading. Not being in a position to check these figures by a scientific investigation, I will give my practical operating experience with badly scaled tubes.

Some years ago there were installed at one of our plants three 2,640-sq.ft. horizontal water-tube boilers, operating at 150 lb. pressure. When these boilers were installed, no provision was made to treat the feed water, but the usual precaution was taken to prevent scale forming in the tubes by giving the boilers a regular cleaning. After 18 months of service the boilers were so badly scaled that some means had to be provided to prevent the scale from forming in the boilers. A live-steam purifier was later installed, and this removed a

Section of clean and scaled tube taken from boiler after 15 months' service

large percentage of the impurities and practically eliminated our troubles from scale. The piece of tube at the right in the illustration shows the badly scaled condition of the boiler tubes at the time the purifier was installed.

After the scale had been removed from the tubes of these three boilers, amounting to several hundred pounds, I had an opportunity to prove that the figures given in the handbooks were not correct. Undoubtedly, there was a saving in the consumption of coal, but in this case, according to the percentages given in handbooks, the savings should have been enormous. The saving was a disappointment; it was not one of those cases we read about of two boilers doing the work of three, and far from it.

[Investigations on this subject were carried out some time ago at the University of Illinois and the results published in a bulletin.—Editor.]

THOMAS PASCOE.

Norway, Mich.

Exhaust vs. Live Steam for Heating

[A letter on "Exhaust Steam Versus Live Steam for Heating Purposes," by John G. Smedley, Jr., in the March 16 issue, assumed it to be a fact that it requires less fuel to generate power by an engine and heat a building with the exhaust than it would take to heat the building directly with live steam and generate no power. Mr. Smedley offered an explanation of this which has led to discussion as follows: H. A. Ward, page 539, April 6; editorial, page 569, April 13; Walter Stanley, page 577, April 13; L. H. Stark, page 613, April 20; Frank Engelhardt, page 647, April 27; L. A. Pierson, page 690, May 4; H. J. Marks, page 726, May 11; S. W. Hay, page 789, May 18; Berry Ervin, page 863, June 1; W. B. Lewis, June 15, page 942. Four more discussion letters follow. Because of space limitations, portions dealing with points already covered adequately in previous letters have been deleted. It will be necessary to close the discussion with these four letters unless new data of particular significance are presented.—Editor.]

The editor brought out several important points in his discussion on exhaust- versus live-steam heating, in the April 13 issue. It is true that from a theoretical viewpoint there is less heat available for heating buildings after the steam has expanded in an engine cylinder, than there is if the steam is taken directly from the boiler through a reducing valve. It is also true that many heating plants have a higher coal consumption when the engine is shut down than when it is running, even though it seems an impossibility. By considering the following facts the reasons for the discrepancy are partly explained: Most heating plants fifteen years or more old have heating mains that were designed to serve the radiation that existed fifteen years ago and much radiation has been added with no increase in the size or number of mains. This results in higher velocity in the mains, which necessitates much greater pressure drop.

Let us assume that we will heat with exhaust steam at 5 lb. pressure today and tomorrow we will endeavor to heat with live steam at the same pressure and shut down our engine, outdoor temperature and wind conditions being the same. The superheated steam discharged by the reducing valve would have a greater volume per pound than the engine exhaust. To pass the same amount of steam through the main, it might be necessary to raise the live-steam pressure, say, 13 lb.

We all know that no heating plant is in perfect condition and that numerous leaks may exist and all leakage losses increase with the pressure. Any condensation wasted to the sewer at 13 lb. pressure and 246 deg. F. must be replaced by makeup at temperatures as low as 40 deg. in winter months. Less makeup is needed when the pressure is 5 lb., as with exhaust-steam heating, since the leakage through traps and untrapped drips is less. Any great increase in makeup at 40 deg. will lower the feed-water temperature and raise the fuel consumption.

Several coils may be discharging condensation directly into an open heater in the boiler room, the valves on the coil drip line being either hand-regulated or wide open. Since the heater vents to the atmosphere, the loss is greater at 13 lb. than at 5 lb. pressure. Even with all coils trapped, this loss will exist in connection with an open heater where not enough cold makeup enters to cool the condensation to 212 deg.

Another point comes up where the return lines are small and a vacuum of 10 in. or more is required to keep the system drained. The water entering the vacuum pump must be below 190 deg. or the vacuum will be destroyed. The cold water admitted at the pump suction when the condensate is coming from the coils at 5 lb. pressure, may not exceed the makeup needs, but if the condensation is at 13 lb. the amount of cold injection water may be increased to a point where large quantities of water at 190 deg. must go to the sewer, thus calling for more fuel.

It is decidedly unfair to point out that more coal is burned to heat the buildings to 65 deg. on Sunday with live steam than to heat to 70 deg. during a weekday. The respiration of human beings and animals, and their radiation, tend to heat the air immediately surrounding them.

It is equally unfair to cite the case of a plant where the boilers were fired by a competent engineer when the engine was running and after the engine was scrapped in favor of purchased power, a cheaper man was hired to run the boilers at low pressure.

Another point that bears on the question is the difficulty of heating remote coils. In order to get good circulation in one or two coils, it is necessary to raise the pressure on the mains. To improve the circulation other bad practices are introduced, such as opening bypasses on traps and neglecting to close them. This trouble with remote coils is aggravated when live steam is used, for the reasons already given; that is, reduced capacity of mains and branches when carrying superheated steam in place of wet exhaust steam. Cold water sprayed into the mains on the low-pressure side of the reducing valve will give steam of the same quality as exhaust steam and will increase the heat-carrying capacity of the mains. Much of the trouble encountered with live-steam heating can be overcome by correct design, mainly steam mains and returns of ample size, coils pitched instead of horizontal, to facilitate drainage.

A. F. SHEEHAN.

Brightwood, Mass.

In the several articles appearing in *Power* on the subject of heating buildings by live or exhaust steam, no mention has been made of the type of building or its use.

If a manufacturing establishment the matter of air movement caused by moving belts, machinery and motors should be considered. Belts alone would cause a big difference in temperature for, as the hotter air would be near the ceiling during the time when the building was heated by live steam with no moving belts or machinery, it would not be felt by one walking on the floor, but when the factory was in operation this hot or warm air would be put in circulation.

Central Moron, Camaguey, Cuba. EDWIN C. BLISS.

Mr. Smedley's reasoning is sound; I differ from him only that if live steam be given a chance it will give up its heat the same as exhaust steam. The condensation in the radiators is controlled by traps of the thermostatic principle, and with live steam the traps open and close often and at every opening steam goes through before they can close again. This condenses in the return line, giving up its latent heat to the return water. When the water gets to the vacuum pump, it has a higher temperature than that corresponding to

the absolute pressure in the pump, with the result that some water breaks into steam again. If this is not condensed by injecting cold water, the pump will become steambound. When heating with exhaust steam, the traps are open for longer periods or slightly open nearly all the time, because the steam is wetter and only water will go through the traps. Therefore, hardly any water is needed for injection.

In some heating plants as much water is injected as is used for boiler feeding. The thermal efficiency of a high-pressure heating plant depends largely on how much water is injected to the vacuum pump.

Chicago, Ill. OTTO QUENZEL.

The discussion of the relative merits of exhaust and live steam for heating has brought out some points of great practical importance. If it is a fact that the exhaust from a steam engine is really more efficient for heating purposes than live steam at the same pressure, it is very desirable that we should discover the exact cause of this.

Unfortunately, one often hears statements of a similar nature, which, although made in perfectly good faith, upon close investigation prove to be misleading.

If it can be shown definitely that an intermittent pulsating supply produces an efficiency anything like that indicated by H. A. Ward (April 6 issue), it suggests the advisability of introducing the principle of intermittent supply on all steam-heating systems. The question is immediately raised as to the advisability of introducing a motor-driven rotating valve or similar device on low-pressure heating systems which feed directly from the boiler, in order to produce an intermittent feed and thus increase the efficiency of the system.

If the radiator is properly trapped, the heat given out by the radiator per pound of steam condensed should not be affected, as only water should be allowed to pass through the trap, and if the water acts as an insulator, it would only slow down the rate of condensation, but this should not increase the steam consumption per B.t.u. radiated.

It may be worth while to raise the question as to whether a foggy mixture of condensed and uncondensed steam may give up its heat so slowly to the thermostatic element of the trap that a great deal of it will pass through, thus causing the loss of the latent heat in the uncondensed steam.

In case the coils or radiators are not provided with thermostatic traps, but are provided with inlet and outlet valves adjusted upon the assumption that most of the steam in the radiator would be condensed before it would reach the discharge end, anything that would reduce the efficiency of the radiator would tend to cause the steam or condensation to be discharged at a higher temperature than necessary and thus cause a larger steam consumption.

If we compare the use of steam from the engine exhaust with steam that has been generated at high pressure and passed through a reducing valve, we must not overlook the fact that in the first case the radiators are probably getting wet steam, and in the second case the steam has been superheated and if the radiator is not properly trapped the discharge might be at too high a temperature.

In case we operated our high-pressure boiler at low pressure, the adequacy of the steam releasing space, and especially of the steam outlet, should be considered, whereas if we should supply high-pressure instead of low-pressure steam to the radiators, the temperature of the discharge would have a considerable bearing upon the efficiency.

It would appear from the foregoing that the whole subject should be thoroughly investigated before accepting the conclusion that an intermittent feed will raise the efficiency of a steam-heating installation. At the same time if the desirability of an intermittent or pulsating feed be established, it would be a very simple matter to take advantage of this fact by other means than that of installing a steam engine.

Newark, N. J. JAMES O. G. GIBBONS.

For the same weight of dry saturated steam (at a stated pressure) leaving the boiler, everyone should agree that the quantity of steam going through an engine and performing work, cannot possibly have the same number of heat units when entering the heating main as an equal weight passing through a reducing valve and doing no work. When we are apparently getting something for nothing, we should investigate thoroughly because we may be deriving benefit from another element or law with which we are unfamiliar. Few writers have said anything about saving by changing methods or heating installations.

A person heating with live steam is likely to have a higher pressure and hence a warmer building than when using exhaust steam.

In heating buildings for occupancy there are two evident forces to contend with—nature and human nature. Neither will give you the same combination to fight two days running. With nature you have outside temperature, wind and humidity. Outside temperature and velocity of the wind are the two elements that determine how much coal it is going to take to maintain an inside temperature of, say, 70 deg. Humidity determines the relative comfort of those occupying the building, for a temperature of 75 deg. may seem cool with low humidity, while a temperature of 70 deg. may seem to be warm when the humidity is high. Although few engineers may realize it, psychology is an important factor in heating buildings. Some like it hot and again others don't. Some want the windows open all the time and others want them shut.

By overhauling our heating system and following a plan of heating, we have reduced the amount of coal used to heat our factory nearly 20 per cent. The plan is not to maintain a higher temperature at any time than feels comfortable, being especially careful when starting the heating season not to overheat. This is most important. We let the temperature drop as low as it can safely go during the night and over Sunday. The lower the indoor temperature the less heat will be transmitted through the walls of the building. When heating the plant up to the working temperature, the rooms need not be up to the average temperature at the start, as the employees come in from the cold and a lower temperature feels comfortable to them. Every plant has its kinks in heating.

Rockland, Mass. BURTON W. WHEELER.

A CORRECTION—In the second paragraph of the letter on page 723 of the May 11 issue, entitled "Is Race an Obstacle?" reference was made to the State of Michigan. This should have read the State of Ohio.

Questions and Answers

Provision for Tube Expansion

What provision is made for the contraction and expansion of the tubes in a water-tube boiler?

The contraction and expansion of the tubes are cared for through the flexibility of the headers in case of header boilers, and by the curvature of the tubes in boilers where the tubes enter the drums.

Which Should Have the Greater Lead?

In a horizontal compound engine should the high-pressure or the low-pressure valves have the greater lead?

Since the clearance volume of the low-pressure cylinder is much greater than that of the high-pressure cylinder, it is usually advisable to give the low-pressure steam valves the greater lead so that the clearance is filled with steam at receiver pressure at the end of the stroke. The open valve also prevents wiredrawing.

Adjusting Load on Compound Engine

If it was found that the low-pressure cylinder of a cross-compound engine was doing more work than the high-pressure cylinder, how could this be corrected? Would the same rule apply for a tandem compound engine?

If the cutoff of the low-pressure steam valve is shortened, the receiver pressure will rise since it cannot flow into the low-pressure cylinder as fast as it enters from the high-pressure cylinder. As a consequence the back pressure in the high-pressure cylinder will rise, and the mean effective pressure will decrease to such an extent that the low-pressure output even with the shortened cutoff becomes equal to that of the high-pressure cylinder. The same applies to a tandem compound, although it is customary to control both high and low cutoff by the governor.

Frosting of Compressor

Is there too much ammonia in the system, when the frost is carried to the suction valve; the discharge in the compressor is hot and the ammonia in the receiver is up to the top of the gage glass; that is, the receiver is full? By opening more on the expansion valve, the ammonia in the receiver will come down a little, but the machine cylinder freezes over and the discharge comes out cold.

If the frost is carried to the suction valve, you may be assured that enough liquid is coming over with the suction gas to cause the moisture in the air to settle on the valves, as this liquid ammonia evaporates and some liquid may be carried into the cylinder. The fact that upon opening the expansion valve a little, the ammonia in the receiver will come down but little and the machine cylinder frost over, indicates that you are carrying your coils pretty well filled with liquid, and it is suggested that you shut down on the expansion cock so that the frost does not come nearer to the compressor than the suction elbow immediately ahead of the suction valve.

Valves Remain Open

What may cause Corliss type valves to remain open after they have tripped?

The dashpot may be out of adjustment so that no vacuum has been formed as the steam valve opens and enough air exists to prevent the light weight of the parts pulling the valve closed. A second reason is the lodgment of a bolt, piece of iron or heavy scale across the valve opening. A third cause is a dashpot rod so long that it holds the valve open even when the dash is at the bottom of the pot.

Removing Oil from Return-Tubular Boilers

How is oil removed from return-tubular boilers?

The best way to remove oil from any boiler is to prevent it getting in. It is a hard problem to get rid of oil in boilers, especially if it is coming in regularly. Blowing down will not cure the trouble then, although it may help some. Compounds will help to get rid of the oil if followed up with a complete wash down. Steps should be taken to prevent more oil coming in. Oil separators of ample size should be placed in all exhaust lines, and filters must be resorted to if the separators fail.

Ash in Refuse

With coal containing 10 per cent ash and costing $5 a ton, there is 25 per cent combustible in the ash. What part of the $5 goes into the ashpit?

In order to solve this with the conditions given, it must be assumed that all the ash finds its way into the ashpit, which in many cases is not strictly true, as some ash may find its way up the stack when operating under appreciable draft. It is further assumed that the 10 per cent ash refers to the chemical analysis of the coal.

Each ton (2,000 lb.) of coal as bought would contain 1,800 lb. combustible and 200 lb. of ash. Considering that it is only combustible for which you are paying money, each pound would cost $\frac{\$5}{1,800} = \$0.00277$ or 0.277 cent. The refuse in the ashpit would be $\frac{200}{0.75} = 266$ lb., representing 200 lb. of ash and 66 lb. of combustible. Since each pound of combustible costs 0.00277c., 66 lb. would cost 18 cents. That is, for each $5 paid for coal, 18 cents is wasted in combustible in the ashpit.

Another way of looking at the problem is that in buying the coal originally, you are paying as much for the ash as for the combustible, and each pound of coal as purchased costs $\frac{\$5}{2,000} = \$0.0025$, or ¼ cent. Hence the 266 lb. of refuse in the ashpit would cost you $266 \times 0.0025 = 66\frac{1}{2}$ cents.

Which solution one accepts depends upon the interpretation of the question.

Pulling Liquid Ammonia into the Compressor

Can an ammonia compressor be damaged when enough liquid ammonia comes over to cause the cylinder to frost over?

The fact that the cylinder frosts over indicates that considerable liquid has been pulled over by the suction gas, and there may be enough remaining unevaporated when the piston reaches the end of the stroke, to fill the clearance and probably break one of the valves or the piston.

Figuring Steam Velocities

What will be the steam velocity necessary to transmit 23,000 lb. of steam per hour through a 6-in. extra-strong pipe if the steam pressure is 160 lb. gage and the superheat 90 deg. F.?

Pipe tables show that 6-in. extra-strong pipe has an internal diameter of 5.76 in. and an internal cross-sectional area of 26 sq.in., or 26.0 ÷ 144 = 0.180 sq.ft. The specific volume of steam at 175 lb. absolute and 90 deg. superheat is 3 cu.ft. per pound (page 50, Marks & Davis Steam Tables). The flow of 23,000 lb. per hour amounts to 23,000 × 3.00 = 69,000 cu.ft. per hour = 69,000 ÷ 60 = 1,150 cu.ft. per min. Dividing this by 0.180 sq.ft. of cross-section gives a steam velocity of 6,390 ft. per minute.

Idling Diagram of Gas Engine

When taking diagrams from a gas engine and using a cord attached to a small crank on the end of the shaft, the diagram often shows a loop like a light-load diagram when no ignition is allowed to occur. Is this correct?

When taking an indicator diagram from an internal-combustion engine with the ignition cut out, it is to be expected that a small loop diagram would be obtained. This is due to the fact that there is a heat loss during compression, and also one during expansion, and the loss during expansion will cause the pressure to drop below that at the same point of stroke on the compression stroke. However, if this loop is at all decided, one should look for an error in the reducing motion. It does not take much looseness in the various joints of the indicator mechanism to cause a distortion in the diagram. To offset this, turn the engine over by hand and take an atmospheric pressure line during the up-stroke. After doing this, turn the engine gradually over to dead center and see when the pencil first begins to make a mark. If this is at the same point as it left off on the up-stroke, then one may be more or less assured that there is no error in the mechanism. To compensate for any wear in the pin, a very strong spring may be hooked onto the indicator rigging connecting rod, or crosshead, so that the strain is all taken in one direction.

Superheating Steam by Reducing

In passing saturated steam through a reducing valve to a lower pressure, does the steam on the low-pressure side become superheated and if so, how much? Show in figures just what happens to all the B.t.u.s in each pound of saturated steam after it is reduced from 100 lb. absolute to 30 lb. absolute.

When steam passes through an orifice or reducing valve, the steam in the low-pressure side, per pound, has as much heat in it as it contained while on the high-pressure side. In other words, since no work has been done, the heat content remains constant. In the case mentioned the steam is at 100 lb. absolute pressure, dry saturated, and has a total heat content of 1,186.3 B.t.u. After expanding to 30 lb. pressure, each pound has this same number of heat units in it. Now, dry saturated steam at 30 lb. absolute pressure contains only 1,163.9 B.t.u., consequently the difference, or 22.4 B.t.u., will superheat the steam. Allowing two degrees per B.t.u., the 22.4 B.t.u. will superheat the steam about 45 deg. The total steam temperature is going to be in the neighborhood of 250 + 45 = 295 deg. F. A more precise result is obtained by looking in the superheated steam tables for a steam temperature that will give 1,186.3 B.t.u. at 30 lb. absolute. This is found to be 296.2 deg. This temperature is less than the original temperature of the steam, which is 327.8 deg. F.

Rule for Pulley Speeds

What is the rule for figuring the sizes and speeds of pulleys?

Where two pulleys are belted together, the following relation holds: Diameter first pulley × r.p.m. first pulley = diameter second pulley × r.p.m. second pulley. If the first pulley has a diameter of 12 in. and runs at 160 r.p.m., and the second is to run at 90 r.p.m. we have

$$12 \times 160 = \textit{diameter second pulley} \times 90$$

$$1{,}920 = \textit{diameter second pulley} \times 90$$

$$\textit{diameter second pulley} = 1{,}920 \div 90 = 21.4 \textit{ in.}$$

It is sometimes customary to add the thickness of the belt to the diameter of the pulley to get the diameter used in the formula, but this refinement is generally not worth while.

What Caused the Watt-Hour Meter To Stop?

What is the cause of a polyphase watt-hour meter stopping? The generator is driven by an oil engine and is rated at 62.5 kva. 60 cycles, 300 r.p.m. 2,300 volts. There is also a 45-kva. motor-generator set. The oil-engine driven generator generally carries about 8 amperes per terminal and is a three-phase machine. The motor generator generally delivers about 1½ amperes per terminal. The oil engine carries the load until midnight, and when it is in operation the meter has never stopped. We change to the motor generator at midnight, and sometimes while this machine is in operation the meter stops three or four times an hour, then it may run for a month and not stop. Both machines supply power to the same system.

It may be that the friction of this meter has become excessively high for some reason, and during very light loads sufficient torque is not produced to cause the rotating element to move. It would be advisable to have the meter tested to see if it is recording correctly. The load on the system after 12 o'clock is probably mostly transformers without any load on them, in which case the power factor of the system is very low, and although the generator delivers a load of 1½ amperes per terminal to the system, this current represents very little power. A watt-meter on an alternating-current circuit does not indicate the product of the volts times the amperes, but the product of the volts times the amperes times the power factor. If the power factor is very low, you can quite readily see that the power transmitted is small and may not be sufficient to turn the watt-meter, particularly if the friction of the meter happens to be high.

A new slant on things observed in and out of the power plant

What Happens and Why?

The Astronomy of Exhaust Steam

AS HAS been pointed out in previous articles[1], coal is but a small fraction of the total weight of material handled in the power plant. To burn one ton of carbon requires a minimum of 11.52 tons of air, the combustion producing 12.52 tons of flue gas. Ordinary coal requires, theoretically, about one pound of air for each 1,300 heat units; thus a 13,000-B.t.u. coal would have a theoretical requirement of 10 lb. of air per pound of coal. Actually, after allowing for an excess of about 50 per cent, the air required to burn a ton of average coal would be about 400,000 cu.ft. This would produce approximately the same volume of flue gas if the latter were measured at the same temperature. Measured at flue temperature, the total volume would be about 800,000 cu.ft., enough to fill a balloon 115 ft. in diameter. It was pointed out in the article in the June 8 issue that the gases issuing from the stacks of the Hell Gate Station at full load would fill the U. S. Navy Dirigible, "Los Angeles," in 72 seconds. When one considers that this airship is 660 ft. long and has a gas capacity of 2,400,000 cu.ft., it is clear that on a volume basis—and even on a weight basis—the coal pile shrinks into insignificance when compared with the flue gas.

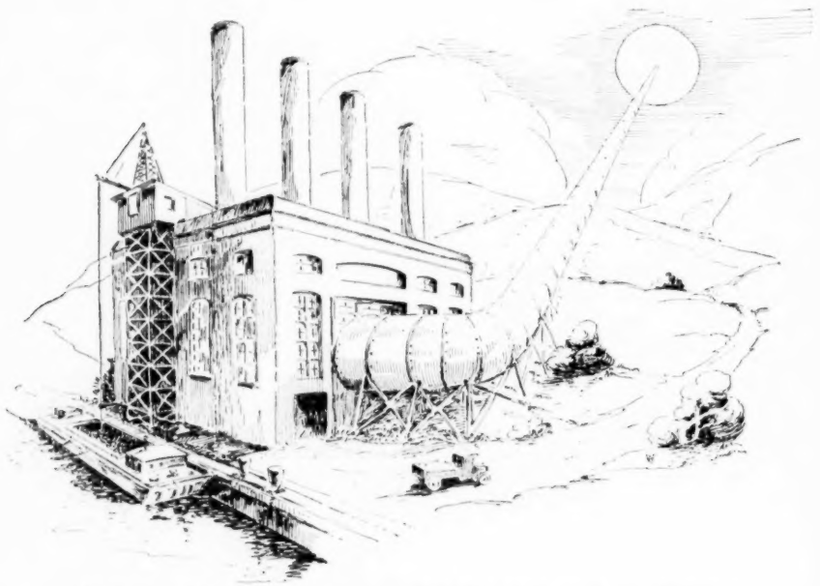
[1] "Flue-Gas Volume Dwarfs the Coal Pile," in May 25 issue, and "Flue-Gas Computations Give Surprising Results," in June 8 issue.

The weight of steam produced averages about two-thirds that of the flue gas in well-operated plants. The volume is also less than that of the flue gas if the steam is measured at atmospheric or higher pressure. At condenser pressure this condition is reversed. The volume of the steam there becomes so great as to make all other quantities handled in the power plant absolutely insignificant in comparison. The figures then become truly astronomical.

Suppose we do a little figuring with a 50,000-kw. unit. Assume that it is operating at full load with steam bled for feed heating and that it is exhausting to the condenser 9½ lb. of 90 per cent dry steam per kilowatt-hour. The total weight exhausted per hour will be 50,000 × 9½ = 475,000 lb. At 29-in. vacuum one pound of dry steam occupies 655 cu.ft. For 90 per cent dry steam the volume would be 90 per cent of this, or 590 cu.ft. Multiplying this by 475,000 lb. gives a total of 280,000,000 cu.ft. per hour. A year of continuous day-and-night full-load operation brings the grand total to 2,450,000,000,000 cu.ft. Surely none will dispute that this figure is of astronomical proportions. Of course, one would expect a lot of exhaust steam to be produced in a year, but how about a short period—one second, say? The exhaust in a single second would amount to 78,000 cu.ft. This would fill a pipe one mile long and 52 in. in diameter. In an hour the exhaust would fill a pipe of this size reaching from New York to San Francisco. It is not contended, of course, that the steam could actually flow a mile each second.

Coming back to the 2,450,000,000,000 cu.ft. that would be exhausted in a year, let us look for something big to compare it with. Take the moon, for example. According to the encyclopedia the average distance of the moon from the earth is about 240,000 miles. Turning this into feet and dividing it into 2,450,000,000,000, gives 1,930 sq.ft., which is the cross-sectional area of a pipe about 50 ft. in diameter. The fantastic scene depicted in the accompanying sketch has this much of truth in it—the exhaust steam from a single 50,000-kw. unit operating at full load, day and night for a year, would be sufficient to fill a pipe 50 ft. in diameter running from the earth to the moon.

MEASURED at condenser pressure, the exhaust of a 50,000-Kw. turbine at full load would fill a 52-in. pipe one mile long in one second. In an hour it would fill a 12-in. pipe circling the earth 2.7 times. In a year it would fill a pipe 50 ft. in diameter reaching from the earth to the moon!



In a year the exhaust steam would fill a pipe 50 ft. in diameter, reaching from the earth to the moon

If the moon seems a little too close to suit the reader, he may take the sun, which is 93,000,000 miles away. In a year the exhaust steam would fill a pipe 2.51 ft. in diameter running from the earth to the sun.

Other interesting comparisons may be worked out. In one hour the exhaust steam would fill a vertical cylindrical tank 595 ft. in diameter and 1,000 ft. high, or a one-foot pipe running around the earth at the equator 2.7 times. To hold the steam exhausted in a year would require a one-foot pipe running around the earth at the equator 23,600 times. It is asking a lot to expect the reader to take this last statement on faith, but he can check it approximately for himself if he wishes.

It is no wonder, then, that turbine builders have to give a lot of attention to the design of the low-pressure ends of large units. Even if the cross-sectional area of the connection from the 50,000-kw. turbine to the condenser were 200 sq.ft., the velocity at this point would have to be about 400 ft. per sec., or 274 miles per hour to handle the steam. Steam leaves the last row of blades in the turbine at a still higher velocity. This represents a direct loss of energy and is one of the most perplexing problems encountered by the turbine designers.

New and Improved Equipment

Triangle Armored Cable Tool

The illustration shows a tool recently developed by the Triangle Conduit, Inc., Brooklyn, N. Y., to permit quick and

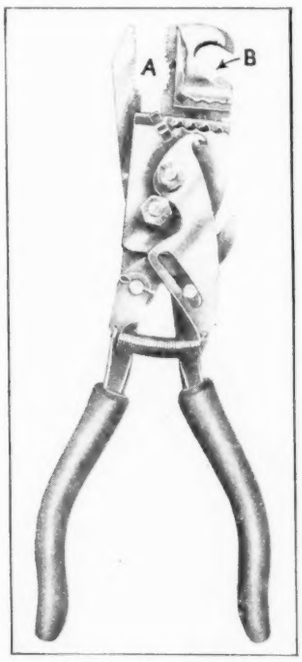


Fig. 1—Pliers with armored cable-stripping attachment

clean stripping of the steel from the wire of armored cables without danger of injuring the conductors or their insulation.

The tool is essentially a pair of pliers

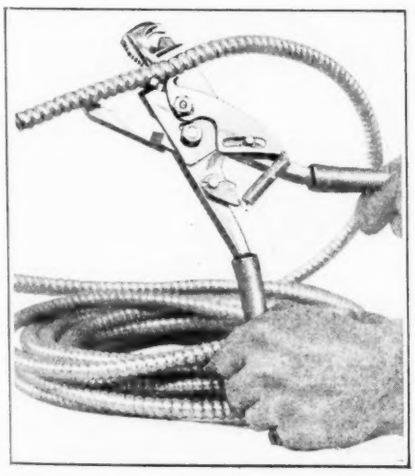


Fig. 2—Tool on cable ready for parting

fitted with wide-mouthed pliers *A* and a cutting device *B*. The tool is designed to strip any single-strip armored cable in sizes 14-2, 14-3 or 12-2 without any adjustment.

Fig. 2 shows the tool on the cable ready for stripping, which is done by simply opening and closing the handles. The cutting device *B* is designed to cut wire, cable or non metallic conduit up to ½ in. outside diameter.

New Connecticut Exhaust Fan

A type of fan in which the inlet opening is placed adjacent to the discharge in place of at the center, as is the usual practice, is a recent develop-

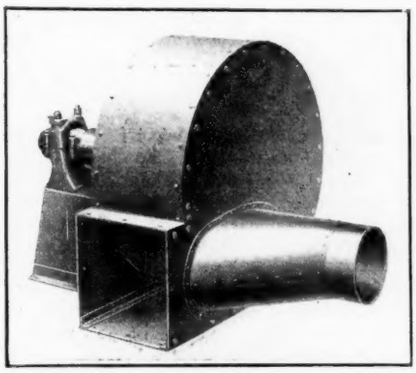


Fig. 1—General view of exhaust fan

ment of the Connecticut Blower Corp., Hartford, Conn. The fan is adapted to handling flue gases, acid fumes, grinding dust, sawdust, etc.

Fig. 1 is a general view of the fan showing the relative position of the inlet and discharge openings, and Fig. 2 is a plan view showing the flow through the fan. From Fig. 2 it will be seen that the material has a short travel through the fan and that it is discharged without passing through the wheel or around the housing. This feature tends to reduce the wear on the wheel and housing materially and obviate the trouble from material adhering

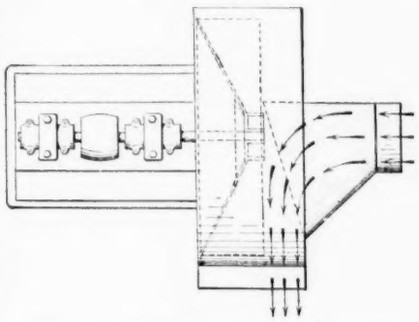
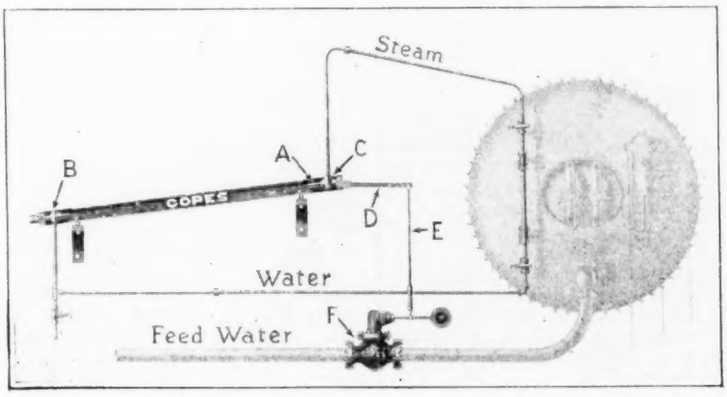


Fig. 2—Plan showing short travel through fan

to the wheel and throwing it out of balance. The fans are built with inlet diameters from 9 to 33 inches.

Copes Feed-Water Regulator for High Pressures

To the line of "Copes" regulators manufactured by the Northern Equipment Co., Erie, Pa., has recently been added the type *R* feed-water regulator, which is designed especially for use with pressures of 300 lb. and above. Referring to the illustration, the expansion member *A* is a heavy metal tube welded into the end connections *B* and *C* which permits lineal expansion and contraction of the tube. This movement of the tube is transmitted through the lever *D* and link *E* to the control valve *F*. The tube-end connection pieces, *B* and *C*, are mounted in heavy channel-iron supports, which protect them and the expansion tube from damage. The steam and water connections to the regulator are arranged as shown.



Type R regulator for pressures above 300 pounds

Improved Dionic Water Tester

The accompanying illustrations show the improved model of the dionic water tester supplied by James G. Biddle, 1211-13 Arch St., Philadelphia, Pa.

The apparatus is especially adaptable for the testing of boiler water and condensate, but can also be used for testing any dilute solution.

Based on the theory that when the nature of any substance in solution is known, the conductivity of the solution is a measure of its amount, the dionic tester provides a simple and direct method of measuring this conductivity

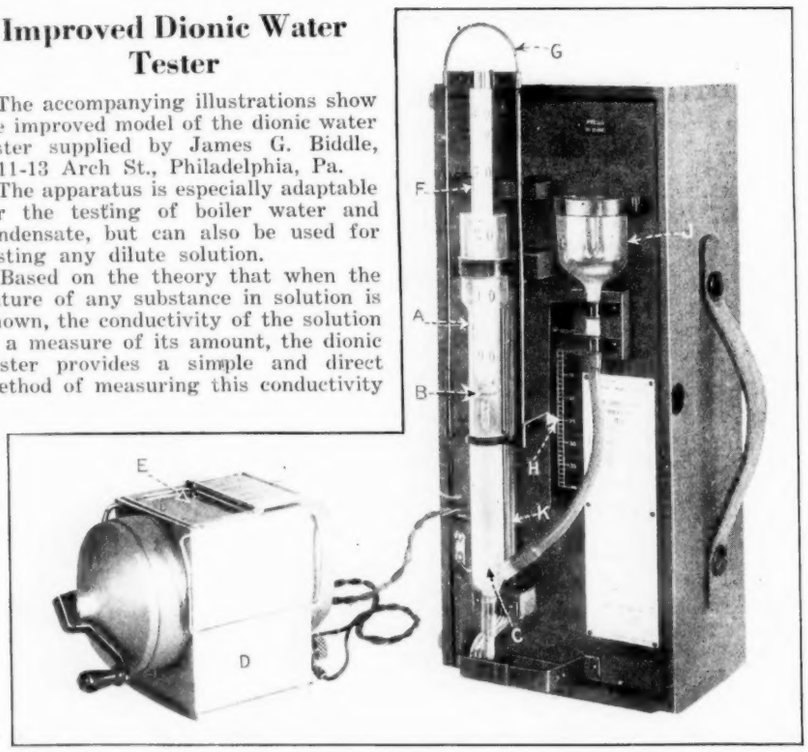


Fig. 1—Portable instrument ready for test

and from this reading the strength of the solution is readily determined. It will therefore be seen that if a certain standard is set for the concentration of the boiler water and a measure of the conductivity is obtained, any change of the concentration and the amount of such change may be readily detected.

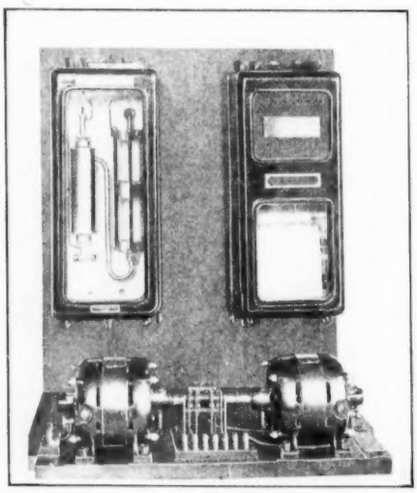


Fig. 2—Recording instrument with conductivity tube and motor-driven generator

Likewise, any change in purity of the condensate leaving a condenser, due to a small proportion of the cooling water leaking into the condenser, is readily detected by a change in conductivity as indicated by the instrument, thus providing a ready means of detecting condenser leakage and of obtaining the percentage of such leakage. Other uses for the instrument include checking the hardness of water, the purity of distilled water, variations in salinity, etc.

Fig. 1 shows the portable instrument set up ready for test. The instrument consists essentially of conductivity tube *A* to hold the water under test, platinum electrodes *B* and *C* for passing electric current through the water, the conductivity meter and direct-current generator *D* for supplying the current.

In operation, a sample of the water to be tested is placed in the conductivity tube *A* and the generator is then turned with the crank, causing a current to flow through the meter and the water in the tube. The pointer of the meter is deflected and comes to rest at some point on the scale *E* which indicates the conductivity of the water in the tube. The meter measures the conductivity directly and without calculation. The readings are in units of conductivity, the unit being the reciprocal of one megohm per centimeter cube between parallel faces.

A feature of the instrument is the provision made for compensating for differences of temperature of the water in the tube *A*. This is done by raising or lowering the thermometer *F*, thus changing the cross-section of the column of water in the conductivity tube. The thermometer is supported in a holder *G* which can be readily moved up or down and to which is attached the pointer *H* moving over a scale calibrated in degrees centigrade. The conductivity tube *A* is filled by pouring the water into the funnel *J* until it overflows out the tube *K*. Then the reading of the thermometer is noted and by means of the holder *G* the thermometer is raised or lowered until the reading of the scale corresponds with the thermometer reading.

Another feature is the method of mounting the instrument on a pivoted side of the case. When the test is completed, the thermometer is lowered into the tube and the side of the case is swung 180 deg. to the closed position.

The size of the generator *D* has been materially reduced over the model previously supplied. The generator is of the direct-current constant-pressure type and, in combination with the meter, is mounted in a compact aluminum case, as shown in Fig. 1. The total weight of the instrument and generator is 7¼ lb.

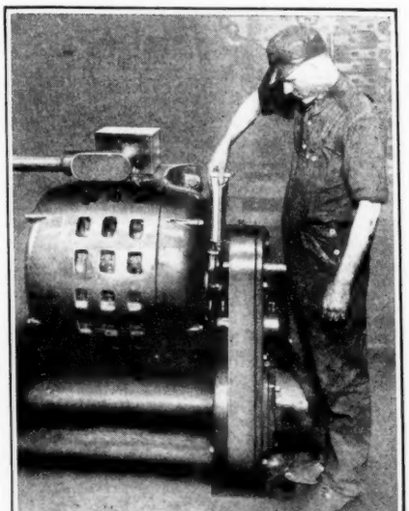
In addition to the portable instrument shown in Fig. 1, a recording instrument complete with motor-driven generator is available as shown in Fig. 2. In this instrument a continuous flow of water to be tested is passed through a special conductivity tube containing the electrodes, and the correction for temperature of the water under test is entirely automatic.

It is not necessary that the instruments be assembled close together, as shown in Fig. 2, for they have no mechanical connection and can therefore be placed at different locations as best suits installation requirements. The instrument can also be furnished equipped with a pilot lamp, which lights when the percentage of impurity rises above a certain point.

Grease-Tube Method of Lubricating Ball Bearings of Motors

The illustration shows the grease-tube method of lubricating the ball bearings of motors, recently introduced by Fairbanks, Morse & Co., Chicago, Ill.

The grease is furnished in collapsible tubes, of which there are four sizes available for corresponding sizes of



Grease is squeezed from the tube into the bearing

bearings. As it is necessary to renew the grease in this class of bearing only once or twice a year, the plan recommended is to flush out the old grease with kerosene, then squeeze the new grease directly from the tube into the bearings.

This method precludes the possibility of dirt or other matter being introduced into the bearing when refilling.

Iron and Steel Electrical Engineers Hold Chicago Convention

SAFETY, electric transportation, refractories, gas-producer operation and the uniflow engine as a reversing-mill drive were among the leading subjects discussed at the twenty-second annual convention of the Association of Iron and Steel Electrical Engineers, held at Hotel Sherman, Chicago, from June 7 to 11. In attendance, character and quality of papers and entertainment provided by the local committee, the convention as a whole was pronounced one of the best in the history of the organization. Registration approximated 600 members and guests. The usual exposition of electrical and mechanical appliances for the steel mill also was held in the hotel, and limited to the 122 booths for which space was available. Social functions consisted of an informal dance Monday evening, a formal dinner dance on Thursday evening, and on Friday the entire day was devoted to the inspection of the Illinois Steel Co.'s plant at Gary and to a golf tournament arranged under the auspices of the company at the Gary Country Club.

Business Session

At the introductory business session Monday morning, S. S. Wales presided in the absence of President George H. Schaeffer. Numerous committee reports were heard, and in a general review of the Association's activities, John F. Kelly, business manager, suggested the expansion of regional meetings, the organization of a mechanical section and the appointment of a number of additional committees, whose annual reports might be collaborated into a handbook that would summarize the best practices in all phases of steel-mill operation. Owing to the advancement of the convention date, the present officers still have three months to serve, so that no election took place at the convention.

Safety Division Meeting

A general luncheon was followed by the first technical session, which was held under the auspices of the Safety Division, with C. L. Baker presiding. As its first work this new division had prepared a set of rules for the safe operation of electric overhead traveling cranes. These rules were adopted and recommended to the steel industry and are in this issue on page 987. Previous to their consideration Dr. W. B. Fisk, chief surgeon of the International Harvester Co., summarized the qualifications desirable in a crane operator and enumerated the physical conditions he would investigate.

In an analysis of 12,000 accidents among 50,000 employees, growing out of electrical operation over a period of years, Charles B. Scott, president of the National Safety Council and director of the Bureau of Safety serving the Insull interests, had found that only 8 per cent could be attributed to electric current, but this 8 per cent of the accidents had caused 75 per cent of all lost time, more than 75 per cent of all accident costs, and over 75 per cent of the fatalities. Attention to safeguards, insulation and safety appliances would reduce the number of accidents, but 70 per cent of the trouble could be attributed to the men doing the work. The remedies were careful selection of men, careful instruction of the men in their work and careful and close supervision of the men doing the work.

REVERSING blooming-mill uniflow engine has a rating of 30,000 hp. at maximum cut-off, operates condensing and is supplied with steam at high pressure and superheat.

An analysis of 12,000 accidents growing out of electrical operation showed that only 8 per cent could be attributed to electric current, but this 8 per cent had caused more than 75 per cent of all lost time, accident costs and fatalities.

The opinion was expressed that no great improvement could be expected in common refractories, although much could be done to improve their life by furnace design and methods of operation.

An equivalent complement of instruments was recommended for gas-producer plants, as is found in the modern boiler plant, and the plants put into such shape that the management might be tempted to visit them and see where their greatest fuel losses had been occurring.

To get results safety must be made a definite integral part of operation.

A. C. Cummins had found that most of the electrical accidents could be classified under the following six heads; Electric shock, electric burns, failure of electrical machinery, accidents from fires caused by failure of electrical equipment, explosions caused initially by an electric spark, and lack of co-operation. An analysis of each of these items was followed by the suggestion that the safety and maintenance departments work hand in hand to find immediate remedies for the causes of trouble, attacking the problem in the initial stages before the failure or rupture occurs.

According to John A. Oartel, chief of the Safety Bureau, Carnegie Steel Co., the desire to live had not kept men safe in the Pennsylvania Railroad shops. Safety organizations were needed and one of their principal functions was to eradicate the lack of co-operation between employees, this, in his opinion, being the chief cause of electrical accidents.

In enforcing codes for safety, Walter Greenwood, safety engineer for the Carnegie Steel Co., believed first in education and then compulsion; mandatory rules should be explained so that the men will know the reasons back of them. Rather than following instructions blindly, they should be made to understand the general principles of construction and operation, so that in emergencies they will be in a position to use their initiative. Too much dependence should not be placed on equipment and safety devices. In Mr. Greenwood's opinion nothing should be done to take away the idea of the mutual responsibility of all concerned.

Refractories

At the Wednesday meeting a popular subject was refractories, on which four papers had been prepared. W. C. Booze, industrial fellow from the Mellon Institute of Industrial Research, gave a comprehensive review of present conditions, pointing out how improvement in service might be obtained from the common refractories in use and enumerating some of the new developments in this field. His general theme was that in the common refractories no great improvement could be expected, although considerable might be done to prolong the life of refractories by changing furnace designs and methods of operation and by the use of water cooling and suspended arches. The common belief that refractories were not as good as in the past was not generally true. The reasons for shorter life probably were: Greater production, higher temperatures and less time taken to keep the brickwork in repair. The two main causes of failure, slag action and spawling, were being studied thoroughly. Tests more nearly duplicating conditions in practice over longer periods of time were being made, so that valuable information soon would be available. An important point to establish was a suitable ratio between cost and the relative life of the refractory. Something definite on this subject would be of great benefit in new developments.

W. J. Harper, combustion engineer of the Donner Steel Co., outlined his experience with different types of roof for open-hearth furnaces. Martin J. Conway reviewed the refractory problems in a byproduct coke plant, and E. W. Trexler carried the discussion of refractories into continuous bloom and billet heating furnaces.

Gas-Producer Operation

Results obtained from recording instruments installed to guide the operators and check the variations in practice formed the basis of an interesting paper on the operation of gas producers by F. E. Leahy, power engineer of the

Pittsburgh plants of the National Tube Co.

In the discussion it was generally agreed that a more generous use of instruments was desirable. It was suggested that the gas-producer plant be made a separate service department under special supervision, and that the gas maker be made to realize the importance of instruments in guiding the work and in the production of a better and more uniform quality of gas. Ordinarily, the gas house used about three-quarters of the coal required by the mill and the power house the balance. There was every reason why the former should have an equivalent complement of instruments and with their installation a general cleaning up of the gas house would be desirable, so that the management might be tempted to visit the place and see where the greatest losses had been occurring. There was opportunity for advancement in establishing regularity of firebed conditions and then through the use of the instruments approximating boiler-house efficiency. The quality of employees in this department usually was a drawback, but progress could be made by educating the men in the fundamentals of producer operation and making them feel that they had real responsibility in the results.

Standardized Mill-Type Motors

A. C. Cummins, chairman of the standardization committee, outlined the work that had been done in co-operation with manufacturers to produce standardized mill-type motors, with the object of reducing the inventory of spare equipment and economizing in maintenance. It had been agreed that the work of the committee should be limited to external features such as dimensions giving the height of the armature shaft above the bedplate and the over-all length between bearing centers, as well as uniform horsepower ratings and speed. Questionnaires had been sent out to the members, asking for their suggestions concerning types of bearings and frame, changes in speeds and ratings and reduction in the number of sizes. By a unanimous vote the findings of the standardization committee were made a part of the official work of the association, to be made public after a final meeting to check up all details.

Largest Reversing Uniflow Engine

One of the most interesting papers of the entire meeting had been reserved to be presented at the final session. It described the initial venture of the uniflow engine into an untried field, that of a reversing drive for a blooming mill, and was presented by M. J. Conway, combustion engineer, Wheeling Steel Corp. For the first time in the history of the industry the Steubenville plant of the Wheeling Steel Corp. decided to try out a uniflow engine, operating condensing and supplied with steam at high pressure and superheat from a modern boiler plant. Incidentally, the engine had an output at maximum cutoff of 30,000 hp., the largest on record, with a normal capacity to roll 100 tons of steel per hour. This engine and practically an exact duplicate in a continuous mill engine as well as two uniflow engine-driven generating units were installed. In practice, the reversing-mill engine demonstrated its flexibility time and again by rolling as high as 190 tons of steel per hour and during daily routine. Commercial tests made without any attempt to secure conditions favorable beyond the average, showed a steam consumption of 317 lb. per net ton of steel rolled, a remarkable figure when compared to past performances of steam drives. The steam consumption per indicated horsepower-hour, after an allowance of 44 per cent for reversing, plugging and throttling, had been estimated previously at 16.3 lb. More complete details of this engine appear on page 968 in this issue.

Discussion on Uniflow Engine

An animated discussion followed, leading principally to the relative advantages of electric vs. steam drive. Owing to competition with mediocre steam plants and conditions unfavorable to economy, the trend for years had been in favor of the electric drive. Its various advantages were enumerated, such as the higher economy obtained by concentration of steam and electric generation in a central plant, as compared with separate boiler plants supplying steam to engines in widely separated locations. Other advantages were the relative simplicity of providing condensing facilities, transmission by cable rather than steam pipes, smaller space occupied by the motor, cleanliness and numerous other points. The motor either ran at the usual economy or was shut down entirely, whereas many things could happen to the engine drive to affect economy which were difficult to detect. In fact, the same questions had been discussed so frequently before the association and so completely some five or six years ago, that the superiority of electric drive had been considered as definitely established. Some were willing to admit, however, that at least a new basis of comparison had been established, and that a decision required a detailed study of local conditions. Instead of the 45 lb. of steam per horsepower-hour used by the older slide-valve engines operated noncondensing, and the 23 lb. taken by the more modern tandem-compound reversing engine, the present unit showed a steam rate of about 16 lb., which might be compared to the 13 or 14 lb. used in a centralized turbine plant.

Tests on Compound Engines

At the Sparrow Point plant of the Bethlehem Steel Co. the mill motors consumed 17 to 18 kw.-hr. per ton of steel rolled, which in equivalent steam was considerably less than 300 lb. Reference was made to comparatively recent tests on new compound engines, with the steam conditions much the same as at Steubenville, in which the steam rate approximated 600 lb. per ton of steel. As this was nearly double the steam rate of the uniflow engine, there was a desire to know wherein the difference lay and whether it might not be attributed to the inaccuracy of the flow meter measuring a pulsating flow of steam to the engine. This doubt was set at rest by Mr. Spitzglass, of the Republic Flow Meters Co., who explained the difference between a fluctuating and pulsating flow, how easy it was to measure the former and also the latter after dampening or killing the harmonics in the pipe line. In any event, it was generally agreed that a pulsating flow always made a meter read high, so that on this basis the meter should have shown more steam than was actually consumed.

In the average central station today the steam consumption per kilowatt-hour had been reduced to 60 per cent of what it had been right after the war and the coal from 3 to 1.8 lb., as shown by the census. The case of the electric drive, therefore, was improving and the equivalent steam consumption would not be much in excess of 200 lb. per ton of steel.

Near the close of this interesting discussion Mr. Fennell, of the Nordberg company, reviewed the underlying factors leading up to this trial installation, which had been suggested by the success that had been obtained with uniflow engines on continuous mills. Eight different studies had been made as to the most economical plan to follow. Electric service, turbines, etc., had been considered, and the decision was reached that an economical engine operating under favorable conditions of steam and vacuum, would approximate the economy of the electric drive and could be installed at a much lower cost. This plan was carried through and after certain preliminary troubles had been overcome, the installation had more than exceeded expectations. Steam rates per ton of steel rolled were only slightly in excess of 300 lb. and a normal capacity of 100 tons per hour had been carried up to nearly double this figure. The investment was nearly three quarters of a million below what would have been required for an electric installation.

Power Costs Per Ton of Steel

In response the author of the paper, Mr. Conway, pointed out that it was not a difficult problem to keep an engine clean, particularly if equipped with automatic lubrication throughout. Steam lines as compared to electric lines were a comparatively small part of the installation. In reply to the general trend of all questions as to the comparative costs of rolling in dollars and cents, he drew the following comparisons:

At the Sparrow Point plant the power consumption of 17 kw.-hr. per ton, at the unreasonably low rate of ½c. per kw.-hr., would amount to 8.5c. Assuming 22c. per 1,000 lb. for steam and 400 lb. of steam per ton of steel for the uniflow engine, the cost would be 8.8c.

Again, taking the 200 lb. per ton of steel given by an exponent of the electric drive, a turbine water rate of 12 lb. and a cost of ½c. per kw.-hr., the charge per ton of steel rolled would be 7c. The 317 lb. of steam per ton of steel used at Steubenville, at 22c. per 1,000 lb., also would cost 7c.

It was evident that there was very little difference between the two. The deciding factors would be the relative costs of steam and electric current in a particular district and, as shown at Steubenville, the initial investment.

Rules for the Safe Operation of Electric Overhead Traveling Cranes*

1. The operator should be examined by a foreman or someone designated in order that his familiarity with crane parts and their uses, as well as his ability to operate the crane safely may be determined in practice and certified to by the examiner.

2. The operator shall enter or leave his crane at the designated places, making use of the steps or ladder provided at those locations and having both hands free. All materials too large to be carried in pockets shall be raised and lowered by means of a hand line. The hand line must not be attached to the person of the operator.

3. No one but the craneman shall be allowed in the cage except for repairs, inspection, or instruction of new men or for safety of men working on the crane runway.

4. The operator shall keep his crane clean and free from all loose boards, tools, bolts or other objects which may fall on men below or may cause tripping and falling of repairmen when working on the crane.

5. The operator should inspect his crane at the beginning of the turn or at least once each shift and report at once any mechanical or electrical defects, especially noticing the condition of cables, limit switches, signal gongs and collector shoes.

6. The operator shall be responsible for the proper oiling and greasing of his crane, and he should report any defects in the oiling system on any part of the crane.

7. The operator, when about to handle material with his crane, shall devote his entire attention to his work and shall pay careful attention to the following points:

A—Is the hitch of proper length and is it safe?

B—Is the signal given by the proper party and does the operator understand the signal? If in doubt he must not operate.

C—Can the load be carried without passing over the heads of men?

D—Will load clear all obstacles?

E—Test brakes by means of a short lift and return of controllers to "off" position.

F—Allow no one to ride the hook or load.

G—If craneman discovers men on crane runway, he should stop his crane until proper protection is provided.

8. The operator shall avoid bumping other cranes on the runway, but if he is ordered to do so he must move the crane slowly with regard to the safety of men working on or below the idle crane.

9. The operator must not make side pulls unless ordered to do so by a foreman.

10. The operator must be sure that his controllers are in the off position and switch opened before leaving the crane, and in case of failure of power the controllers must be immediately set in the off position.

11. In case a controller sticks the operator must pull the main switch at once.

12. While repairs are being made to the crane, the operator must stay on the job and help with repairs. If ordered to remain in the cage, he must not operate any motion unless he is told that every one is safe.

13. When the operator is inspecting, repairing or lubricating his crane, the main switch must be locked in the off position.

14. In case of a fire on the crane, the operator must use the fire extinguisher provided and must notify the foreman, who shall see that the extinguisher is refilled promptly.

15. An operator must not operate his crane if he is not physically fit to do so. He should report to his foreman at once.

16. The operator must signify his understanding of these rules and must realize that they are intended to help him safeguard the lives of his fellowmen.

Rules for Floormen

1. Floormen when signaling to the crane operator must use the approved crane signals and above all, they must be sure that they do not confuse the operator.

2. Floormen must be responsible for all slings, chains and hooks and for their proper use in order to make safe hitches, bearing in mind the capacity of the slings and of the crane.

3. Floormen shall be sure that the crane trolley is centered over the lift in order to prevent swinging of the load.

4. Floormen must adjust the slings and chains so that they will not strike men on the ground when the crane is moving without a load.

5. Floormen shall not ride the hook or load or permit others to do so.

6. An extra man should be in the crane cage to warn the operator when men are working on the crane runway except where approved track torpedoes are used.

*Adopted at the annual convention of the Association of Iron and Steel Electrical Engineers, Chicago, June 7-11, 1926.

Boiler Insurance Coverage

By Arthur L. H. Street

An insurance policy covering a boiler was not worded broadly enough to make the insurance company liable for the cost of repairing a bag or bulge which formed underneath, held the Ohio Supreme Court in the late case of Cleveland Drop Forge Co. vs. Travelers' Indemnity Co., 151 North Eastern Reporter, 671.

The policy insured against loss caused by explosion of a horizontal boiler, defining "explosion" as a "sudden rupture or sudden collapse of a boiler or its furnace, flues, or other parts, caused by pressure of steam."

Rivets on the lower part of the front head had been so drawn from their position as to enlarge the holes in which they had been fitted. On the under side of the boiler, above the firebox, a bulge about 18 in. in diameter and about 4 in. deep formed. Plaintiff's testimony tended to show that through water dripping into the boiler from the holes made by the sprung rivets, the bulge was formed. This caused an accumulation of sediment at that point, it was further claimed by insured, resulting in the drawing of the rivets from the front boiler plate, leaving an aperture or rupture in the boiler head.

The insured contended that this state of facts showed an "explosion," under the policy, making the insurance company liable, not only for the cost of sealing that rupture, but also for the repairs made to the bag or bulge, although no rupture occurred at that place.

Affirming a decision of the Ohio Court of Appeals to the effect that the cost of repairing the bulge was not covered by the policy, the Supreme Court said:

"By the terms of the policy the insurance company agreed 'to indemnify the assured, . . . in the event of an explosion of any such boiler, for his loss or damage directly caused thereby.' Were this the only provision in the policy contract covering loss or damage by explosion, it is obvious that no liability would attach. There was no explosion in the sense that term is popularly known or as it is defined by lexicographers. However, this policy seemed to recognize this fact, and, with a view of extending its liability by defining the term, it provided that 'an explosion shall mean the sudden rupture or sudden collapse of a boiler . . . caused by pressure of steam.' 'Ruptures' are defined by lexicographers, generally, as a breaking or bursting asunder, and are more distinctly defined in Funk & Wagnall's dictionary thus:

" 'To open or part as a steam bolier, without extreme violence; a splitting apart of a steam boiler as distinguished from bursting or explosion.'

". . . The breaking apart of the boiler head, in which the rivets were sprung, therefore, was a 'rupture' within the meaning of the policy for which the insurance company was liable. Moreover, it was a 'sudden rupture' caused by the pressure of steam, for on the first parting of the rivets from the plate a rupture occurred, and liability immediately attached.

". . . Recognizing that pressure of steam might sometimes not produce explosions of violent character, but might produce a splitting apart of some portion of the steam boiler, with a lesser violence than that produced by an ordinary explosion, the insurer obligated itself to indemnify the assured for the damage directly caused by the rupture. The damage *directly* caused by the rupture was the springing apart of the rivets from the boiler head plate. The damages covered by the insurance policy were those caused directly and not indirectly by the explosion, as therein defined. The insurance company was liable only for the damages caused by the rupture. Those damages included repairs necessary for the restoration of the ruptured places in the boiler."

News in the Field of Power

Storm and Chance Cause Pulverized-Coal Explosion

The power plant of the Virginia Railways Co., at Narrows, Va., was recently the scene of a most unusual pulverized-coal explosion.

Fortunately, a bystander was able to report observations that seem to establish the cause of the accident. A miniature tornado passed over the plant, seemingly over one of the stacks that had been smoking somewhat. As the storm center passed over the stack, the smoking stopped abruptly, and shortly after an explosion tore open the breeching leading to that stack.

Apparently, due to a sudden variation in atmospheric pressure, or due to a sharp downward current of air in the vicinity of the storm center, the draft in this chimney was reversed for a few seconds. This, it seems, blew out a newly lighted fire in one of the boilers. When the storm passed, normal air flow was restored, and the unburned pulverized coal swept up from that boiler was ignited by the hot gas or sparks from boilers whose brickwork was hot enough to maintain combustion.

The explosion wrecked the breeching, but fortunately did little other damage. Some sections of the breeching plates were blown out, other sections were collapsed, evidently due to vacuum following a pressure wave.

Reports failed to state any injuries sustained either by members of the operating crew or chance bystanders.

Not Unprecedented

All available evidence seems to support this unusual explanation, which is not without precedent. Coal-mine explosions have been caused in the same way. Evidently, neither the operating crew nor the nature of the fuel were in any way responsible.

Nevertheless this accident serves as an example of the danger incident to feeding pulverized coal into a cold, unlighted furnace. Sooner or later the coal-air mixture ignites, and the resulting disturbance stirs up the accumulated dust, which then explodes.

New York Licenses Use of Surplus Waters

The New York State Water Power Commission has authorized the issuance of a license for use of surplus waters of the Barge Canal spilled at Lockport into Eighteen Mile Creek at an annual rental of $1,500 a year to be apportioned among the following companies: United Paper Board Company; Lockport Paper Company; Niagara Paper Mills; Tuscarora Hydraulic Co., Inc.; Electric Smelting and Aluminum Co.; Lockport Felt Company; Lockport & Newfane Power and Water Supply Co. The companies accepted the charge.

Power Development An Issue In Parks Conservation

Speaking on the subject of development, more especially that applied to water power, in relation to the conservation of our national parks as recreation play grounds, O. C. Merrill outlined his views of the problem, June 14 before the National Conference on State Parks held at Hot Springs, Arkansas.

"So far as the Federal Power Commission is concerned it has no authority to license a power development in any National Park, stated Mr. Merrill, such authority resting in Congress alone. There have been cases, however, where the Commission has been asked to deny applications for license on the ground, among others, that the area involved should be reserved exclusively for recreation purposes. In one case on Spirit Lake in Washington, the Commission rejected the application on the grounds that the area was at present more valuable for recreation purposes, and that there was no local need for the power and no evidence of ability in the applicant to finance and develop the project. Another case is now pending which affects Cumberland Falls in Kentucky. Since field reports have not been received, and since the record in the case has not been completed it would manifestly be improper for me to discuss the probable action of the Commission, or, in fact, to reach any final conclusion as to the recommendations to be made to the Commission until all the evidence has been received and considered."

Ugliness Unnecessary

"I have seen as you have seen power developments, reservoir sites, transmission lines, railroads, highways, that were so constructed as to be a blot on the landscape; and I have seen others, which did not detract from the beauty of their surroundings, and which produced something of scenic or recreational value where nothing of the kind existed before. I have also seen unsightly and unsanitary camp buildings, and untidy camp grounds within the limits of some of our public parks. The question is seldom one of exclusion but rather of proper adaptation to surroundings. A power plant can be made to fit into the landscape just as appropriately and effectively as a hotel, a dam as a bridge, and a transmission line as a telephone line. We cannot afford to draw distinction on the sole ground that one is for work and the other for play, and that only the latter should be allowed."

"In acting upon projects where both power and recreational values are involved, consideration must also be given to the relative rights and needs of those who live in the immediate vicinity and whose economic welfare or social opportunities may be in large degree dependent upon the proposed development. There are many undeveloped or only partially developed sections of this country, whose industrial progress is dependent upon the development of the natural resources which they possess, one of which particularly is potential water power.

American Steam Engineers Hold Annual Confab

Attending the fortieth annual convention of the American Order of Steam Engineers, held at Philadelphia the week of June 7, were delegates from every council of the order. An exhibition of power-plant equipment and supplies was held by the American Supply Men's Association in a hall adjoining the meeting rooms. More than sixty booths were used by the manufacturers in displaying their products.

Officers of the Supreme Council elected are as follows:

Supreme chief engineer, Thomas Connell, Philadelphia Council, Philadelphia, Pa.; first assistant engineer, Oscar Kurtz, Germantown Council, Philadelphia, Pa.; recording engineer, George Farney, Union Council, Coplay, Pa.; corresponding engineer, William S. Wetzler, Philadelphia Council, Philadelphia, Pa.; treasurer engineer, John J. Kelly, Philadelphia Council, Philadelphia, Pa.; senior master mechanic, Alphonse Seimes, Atlantic City Council, Atlantic City, N. J.; junior master mechanic, James Turner, Municipal Council, Philadelphia, Pa.; chaplain, A. P. Dreisback, Lehigh Council, Allentown, Pa.; inside sentinel, Fred C. Ely, Maryland Council, Baltimore, Md.; outside sentinel. George E. Landis, Progress Council, Reading, Pa., and trustee, Horace Hewlings, Camden Council, Camden, N. J.

Decision on the next place and date of meeting is being considered by the committee and the supreme chief engineer.

A number of entertainment features, including a dinner to the delegates and one to the ladies, a theater party and a general reception, were given by the American Supply Men's Association, adding greatly to the enjoyment of all members and visitors at the convention.

New York Commission to Act on Power Applications

While the calendar of proceedings for the next meeting of the New York State Water Power Commission, to be held at Albany July 8, has not as yet been definitely determined, it is expected with good foundation that the commission will take decisive action on the applications pending before it by the American Superpower Corporation and the Frontier Corporation for the development of power on the St. Lawrence.

Shoals A Power Proposition Say Fertilizer Men

Opposition to production of fertilizer at Muscle Shoals at a figure below that demanded by private enterprise was expressed by Spencer L. Carter, of Richmond, Va., president of the National Fertilizer Association, speaking at the annual meeting of the association, held recently at White Sulphur Springs, W. Va. Mr. Carter said that the association believes Muscle Shoals is primarily a power proposition and should be treated as such. If nitrate is manufactured, it should be made and marketed on the same basis as would be the case in any business conducted by private enterprise, he asserted. Continuing, he said:

"To turn over the two government-owned nitrate plants and the Waco limestone quarry at Muscle Shoals, representing a cost to the government of some $80,000,000, to a lessee with free rent, or at a nominal rent, power being furnished to such lessee at cost or at a figure below that demanded of private enterprise, would constitute a moral injustice to a basic industry intimately related to agriculture and representing an investment of some $300,000,000."

Production Active, But Bill Neglected

While no place on the formal legislative program has been accorded the Muscle Shoals bill, assurances have been given that time will be found for the discussion of this measure.

During May the Muscle Shoals plant delivered 56,288,100 kw.-hr. to the Alabama Power Co. This made it possible to deliver 20,000 kw. to the Southern Power Co., thereby relieving the power shortage in the Carolinas caused by the dry weather.

The fact that power from Muscle Shoals was available during the winter also made it possible for the Georgia Railway & Power Co. to conserve its storage, which now is being used to very great advantage.

Rainfall in the Southeast thus far this year has been 20 per cent below normal.

Boston-Washington Power System Completed

The General Gas & Electric Corp. recently announced completion of the final link in a superpower system extending from Boston to Washington, through the construction of a 110,000-volt transmission line from Dover, N. J., to the New York State line. The power zone, which was planned under the direction of the Department of the Interior, is to run through New England, New York State, Pennsylvania, New Jersey, Delaware, Maryland and the District of Columbia. The territories included in the system are interconnected with the exception of a small mileage between the northern part of Maryland and Washington.

In announcing completion of the new line, W. S. Barstow, president of General Gas, pointed out that subsidiaries in Pennsylvania, New Jersey and New York State were close to coal fields and thus combined water with steam power.

Paris for the First Time Gets Hydro-Electric Power

With the inauguration of the hydro-electric plant at Eguzon, Indre, and the opening of the 90-kv. transmission line connecting this station to the industrial center around Paris, heretofore mainly supplied by the Gennevilliers and other smaller steam stations, the first link in the vast superpower network covering the whole of France, for the purpose of interconnecting steam and water generating plants and the different industrial centers, was officially closed June 5.

This development, planned also to facilitate the electrification of the railroads, the French Parliament provided for, in 1922, by passing a law authorizing immediate construction.

During the week preceding the inauguration of this plant Paris for the first time in history is reported to have received electrical energy generated by water power.

The Eguzon station is on the Creuse River, an affluent of the Loire, at a point about 175 miles south of Paris as the crow flies, where the river leaves the mountainous system of Central France. The head available is 200 ft., and the generating equipment comprises five 10,000-kw. units. One of these is now in service.

The energy generated in this plant is not primarily intended for the consumption of Paris and its surroundings. The first claim is held by the Orleans railroad, which is electrifying its lines over a distance of about 145 miles, between Paris and Vierzon. The 90-kv. twin-circuit transmission line which has just been inaugurated is to supply the railroad, and will be continued south into the heart of the Auvergne Mountains, to carry power from three other plants now under construction on the headwaters of the Dordogne and other streams belonging to this basin. These stations will also be connected to the 150-kv. interconnecting network, and through the latter will supply to Parisian industries the surplus of energy not required by the railroad.

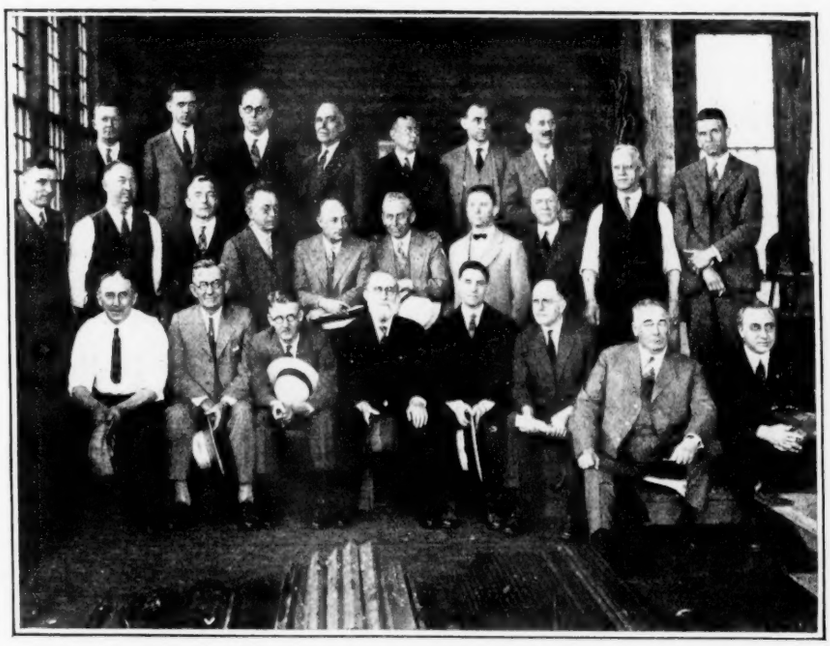
Massachusetts Power Company Buys Right of Way

A happy solution to the problem of finding a new right of way for the power lines of the Turners Falls Power & Electric Co., Springfield, Mass., which will run from Chicopee to Ludlow, has been found in the purchase of the right of way of the old Hampden Railroad by the Montague Co., real estate holding organization for the power company.

Robert W. Mitchell, manager of the Turners Falls Power & Electric Co., who announced yesterday purchase of the railroad's right of way for $35,000, explained that the new power line will run from the company's transformer station in Chicopee to Ludlow, over the erstwhile strip of land designed for railroad tracks.

The assets of the railroad, including ties, track, station houses, and bridges, were sold to Mark Angell of Boston on Saturday for junking.

The property acquired by the Montague Co. consists of a strip of land two or three rods wide, extending from a junction with the Boston & Albany Athol branch in East Springfield to a junction of the central Massachusetts division of the Boston & Maine in Bondsville, a distance of about 14 miles.



At the age of 83, after 46 years of active service in the development of combustion equipment, William McClave, co-founder of McClave-Brooks Company and still its president, took an active part in the company's recent sales convention. He is shown seated in the first row center surrounded by officials of the company, its district managers and a few guests who were invited to inspect the exhibition of grates, hand stokers and mechanical stokers.

Four General Electric Men Awarded Degrees

Honorary degrees have been awarded this month to four prominent men of the General Electric Co., Owen D. Young, chairman of the board of directors of the company, on June 12 received the degree of doctor of laws from Rutgers College. Dr. W. R. Whitney, director of the research laboratory, and E. F. W. Alexanderson, consulting engineer who has gained international fame with his radio inventions and developments, were awarded the honorary degree of doctor of science on June 14 —Doctor Whitney at Syracuse University and Mr. Alexanderson at Union College. A. W. Burchard, chairman of the board of directors of the International General Electric Co. and vice-chairman of the General Electric Co., received the degree of doctor of laws from Union College.

Conowingo Dam Controversy Over Height Settled

Officials of the Pennsylvania Water & Power Co. and the Susquehanna Power Co. have settled the controversy over the height of the concrete dam which the latter will build as part of its hydro-electric development at Conowingo Falls, Md., and the former company will discontinue the litigation it had instituted to enjoin the Susquehanna Power Co. from building the dam and gates at Conowingo Falls higher than 100 ft. above mean sea level.

The agreement permits the Susquehanna Power to superimpose on the crest of a 100-ft. dam steel gates capable of maintaining the pond level at 108.5 ft. above mean sea level. This will to some extent back water into the tailrace of the Pennsylvania Water & Power Co.'s plant at Holtwood, Pa., and will cause some reduction in the power output of the Holtwood turbines. The increase in output at Conowingo, however, will be much greater than the loss at Holtwood. The Susquehanna Power agrees to recompense the Pennsylvania Water & Power for the loss in power at Holtwood, and the net gain at Conowingo will then be divided between the two companies. These compensations take the form of specified annual payments. The contract will run for 50 years.

To Survey Canada's Largest Falls For Power

Having for its principal aim the preparation of a detailed report on McLean's Falls, considered the largest in Canada, an expedition representing the Quebec government will leave shortly to explore the interior of Ungava.

News that the government is sending out such a survey party with the intention of investigating the advisability of utilizing these waters, which are known also as the Hamilton Falls, for electric power, has attracted the attention of the Canadian public to this immense cataract, the existence of which, until recently, was known to but few. The official announcement is vague as to the extent and the potentiality of the Ungava waters, but John McLean, the discoverer of the falls, wrote a descriptive survey of the hydro possibilities.

Largest Rotary Converter Automatically Operated

The largest automatically controlled synchronous converter for railway service was recently placed in operation by the New York Rapid Transit Corp. at their Avenue T Substation. The machine is a 4,000-kw., 575-volt direct-current shunt wound converter and is supplied from a three-phase, 4,200-kva., 11,000-volt, 25-cycle power transformer. The high-tension connections of the transformers are connected in star for starting and in delta for full secondary voltage when the running breaker is closed.

An interesting feature of the equipment is the method of operation by means of supervisory control. To start up the machine, the operator at the adjacent New Utrecht Station operates a small telephone key which initiates the operation of the automatic supervisory relay equipment, resulting in closing of a relay at the substation to start the machine. The machine then automatically starts and connects itself to the alternating current and direct-current systems without an attendant.

In addition to starting up the machine, supervisory control will regulate other operations such as shutting down the machine, operating the 13 feeder breakers, closing or opening the high-tension breakers, and closing or opening any of the six track breakers. The dispatcher has at all times an indication of the position of all the breakers listed above, of the position of the main direct-current breakers, and even of the opening of the substation door.

By a unique method of remote metering the total current furnished by the unit may be read continuously, and by a selective method the current in any one of the individual feeder circuits can also be read by the dispatcher.

Denver Plans Municipal Power Development

The City and County of Denver have applied to the Federal Power Commission for a preliminary permit covering a project on the South Platte River to provide water for municipal use and to develop power. The development includes six reservoirs with a total capacity of 443,200 acre-ft. It is proposed to build a power house at each reservoir. The amount of power to be developed, the height of each dam and the storage are as follows:

Reservoir	Power, Kw.	Dam Height, Ft.	Acre-Ft.
American	4,500	228	80,000
Gheeseman ..	6,750	212	79,000
Deckers	6,000	130	2,900
Two Forks...	18,000	333	262,000
Strontia	12,000	156	1,800
Intake	12,000	228	17,500
Total	59,250		443,200

Building of Texas Plant Nearing Completion

Construction of the first unit of the electric power plant of the Comal Power Co., subsidiary of the San Antonio Public Service Co. at New Braunfels, Texas, is making good progress and will be completed and placed in operation about Sept. 1, acording to Ed H. Kifer, vice-president and general manager of the San Antonio Public Service Co.

Personal Mention

Charles B. Officer, formerly assistant to the president on engineering matters, has been appointed chief engineer of the Sullivan Machinery Co., of Chicago.

H. C. Heink, formerly with the Midwest Piping & Supply Co., has accepted the post of field engineer with the Urbauer-Atwood Co., 1450 South Second St., St. Louis, Mo.

C. J. Ullrich, member of the firm of McGonagle & Ullrich, consulting engineers, Salt Lake City, Utah, has been elected president of the American Association of Engineers for the ensuing year.

G. L. Knight, mechanical engineer of the Brooklyn Edison Co., has been elected vice-president of the third geographical district, New York City, of the American Institute of Electrical Engineers.

J. H. Manning, vice-president of the division of engineering and construction, Stone & Webster, Inc., will shortly transfer his headquarters from Boston, Mass., to the New York office of the company, 120 Broadway.

Edwin A. Childerhose, for the last three years electrical engineer with the Pennsylvania Water & Power Co. and prior to that with the Manitoba Power Commission, has entered the electrical division of Stone & Webster, Inc., of Boston, Mass.

Thomas T. Towles, formerly with the Department of Public Works, Richmond, Va., and prior to that with the DuPont Engineering Co., has recently taken a position as engineer in the structural division of Stone & Webster, Inc., Boston, Mass.

W. S. Maddocks, formerly head of the electrical engineering department of Lockwood, Greene & Co., has terminated his service with that concern to become associated with Stone & Webster, Inc., of Boston, Mass. as engineer in the electrical division.

Dr. Gardner C. Anthony, dean of the Tufts Engineering School since its organization twenty-three years ago, has tendered his resignation to the trustees of the college. He will retire from active duty on Sept. 1, but will be granted a sabbatical leave of one year from that date.

Calvin W. Rice, secretary of the A.S.M.E., has returned from his European tour of scientific and engineering museums. From England, arriving in the latter part of April, Doctor Rice proceeded to Germany, where he conducted the major part of his investigations.

Louis R. Ford, consulting engineer and Diesel engine specialist, has received an appointment from Columbia University as associate in mechanical engineering. He will assume these duties July 1 in addition to carrying on his present engagement as Diesel engineering consultant for the Morse Dry Dock & Repair Co.

A. L. **Oesterle** has been appointed to take charge of the operation of all physical property of the Mississippi Power Co., including plants, transmission lines, distribution lines, street railway, gas and buses.

Albert H. Myers, for several years with Wellman-Seaver-Morgan Co. as engineer in the hydraulic turbine department, and later with Warren D. Spengler, Inc., as chief engineer, has recently joined the hydraulic division of Stone & Webster, Inc., Boston, Mass.

Business Notes

The Lincoln Electric Co., Cleveland, Ohio, announces the appointment of the Cleveland Tool & Electric Co., of that city, as the local distributor of the company's products.

The R. H. Baker Co., 238 Main St., Cambridge, Mass., contractor for power plant and industrial piping, announces the removal of its offices to the New Kendall Square Building, Cambridge, Mass.

The General Electric Co. announces through R. S. Murray, treasurer, the election of Delbert C. Davis and Charles L. Kenyon as assistant treasurers of the company. Both are residents of Schenectady, N. Y.

The Coppus Engineering Corp., Worcester, Mass., announces that Frans H. C. Coppus has resigned as president and treasurer of the company in order to devote most of his time to railway equipment under the firm name of Coppus Locomotive Equipment Co.

The Graybar Electric Co. announces the taking of new and larger quarters for its Buffalo, N. Y., branch house. The new branch house at Buffalo is located at 77-79 Swan Street. Former quarters were at 709 Main Street.

The Graybar Electric Co. announces the appointment of L. W. Conrow, formerly with the research department of the Bell Telephone Laboratories, to its carrier telephone and public address sales department. Mr. Conrow for five years was with the Western Electric Co.

The American Arch Co., 17 East 42nd St., New York City, announces that it has recently consummated, under exclusive license agreement, arrangements for taking over the business of the Waite & Davey Co., Long Island City, N. Y., covering patented air cooled furnace wall blocks, applied in connection with chain grate and underfeed stokers, powdered coal, oil, wood refuse, and bagasse fired boilers.

The Hills-McCanna Co., Chicago, announces the opening of its Eastern sales office in charge of F. R. Glenner, Room 704, 53 Park Place, New York City. Mr. Glenner will have charge of engineering and sales work on Hills-McCanna non-ferrous alloys and products for corrosion-resisting service, as well as the force-feed lubricators and steam specialties manufactured by the company.

The Westinghouse Electric & Manufacturing Co. announces the appointment of A. E. Hitchner, formerly executive of the East Pittsburgh headquarters, as manager of the company's Los Angeles office.

Coming Conventions

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Annual convention at White Sulphur Springs, W. Va., June 21-25.

American Society for Testing Materials. C. L. Warwick, 1315 Spruce St., Philadelphia, Pa. Convention at Haddon Hall, Atlantic City, N. J., June 21-25.

American Society of Mechanical Engineers. Calvin W. Rice, 29 West 39th St., New York City. Spring convention at San Francisco, Calif., June 28-30.

National Association of Stationary Engineers. F. W. Raven, 417 South Dearborn St., Chicago, Ill. Convention at Atlantic City, begins Sept. 14. Erroneously announced as Sept. 6-11. Annual conventions and exhibitions of state associations are scheduled for the following dates:

Connecticut State Association, George F. Klopfer, 30 East Pearl St., New Haven, Conn., Convention at Norwich, Conn., June 25-26; **Wisconsin State Association**, R. L. Scott, Eau Claire, Wis. Convention at Milwaukee, Aug. 3-6; **Minnesota State Association**, C. A. Nelson, 800 22nd Ave., N. E. Minneapolis, Minn. Convention at Rochester, Minn., Aug. 4-6; **New Jersey State Association**, S. G. Dalrymple, 111 Hutton St., Jersey City, Convention at Atlantic City, Sept. 12; **Pennsylvania State Association**, Frank J. McCarron, 3647 North 11th St., Philadelphia, Convention at Philadelphia, Sept. 12-13.

New York State Association. Wilmer T. Meinzer, 3626-215 Place, Bayside, Long Island, N. Y. Postponed from June 11 to 12, at Troy, N. Y., to Sept. 12-13 at Atlantic City, N. J.

Universal Craftsmen Council of Engineers. 24th convention and exhibit Milwaukee Auditorium, Milwaukee, Aug. 3-7.

Charles C. Phelps, distributor of plant equipment, 473 Getty Ave., Paterson, N. J., announces that he and Charles J. Schmid, his associate, have been appointed Metropolitan New York and New Jersey representatives for the Uehling Instrument Co., of Paterson; the Williams Gauge Co., of Pittsburgh; the Combustion Control Division of the A. W. Cash Co., of Decatur, Ill., and the National Boiler Protector Co., of Dayton, Ohio. Mr. Phelps still retains his connection with the Uehling company as treasurer.

Trade Catalogs

Eductor Condensers — Schutte & Koerting Co., Philadelphia, Pa. Bulletin No. 5-B, describing the eductor condenser, which is a simplified type of multi-jet condenser, and shows applications to various types of installation.

Sheath Wire Units—General Electric Co., Schenectady, N. Y. Bulletin describing G-E Helicoil sheath wire units for industrial purposes. A dozen illustrations depict various types made.

Air Compressors and Electric Hoists —Sullivan Machinery Co., Chicago. Bulletin 83-B, second edition, Sullivan single- and two-stage air compressors. This bulletin shows a number of new installation pictures. A new oiling arrangement for the air cylinder, consisting of a force-feed lubricator, driven from the crankshaft of the compressor, and a new type of unloading device, are features of this machine described in this bulletin.

No. 76-G—Portable electric hoist, single and double drum. This is a new edition which has been brought up to date and to which has been added a number of new illustrations showing these small, convenient portable hoists doing various jobs in the industrial, contracting and mining fields.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run except Pittsburgh gas slack:

Bituminous Net Tons	Market Quoting	June 14 1926
Pool 1	New York	$2.50@$2.75
Smokeless	Boston	1.61
Clearfield	Boston	1.65@ 1.90
Somerset	Boston	1.75@ 2.00
Kanawha	Columbus	1.40@ 1.75
Hocking	Columbus	1.40@ 1.70
Pittsburgh	Pittsburgh	1.60@ 1.90
Pittsburgh gas slack	Pittsburgh	1.20@ 1.25
Franklin, Ill.	Chicago	2.25
Central, Ill.	Chicago	2.00@ 2.15
Ind. 4th Vein	Chicago	2.10@ 2.25
West Ky.	Louisville	1.10@ 1.40
S. E. Ky.	Louisville	1.35@ 1.60
Big Seam	Birmingham	1.75@ 2.00
Anthracite Gross Tons		
Buckwheat No. 1.	New York	1.75@ 3.50
Buckwheat No. 1.	Philadelphia	2.15@ 2.75
Birdseye	New York	1.30@ 2.00

FUEL OIL

New York—June 17, light oil, tank-car lots; 28@34 deg. Baumé, 6c. per gal.; 36@40 deg., 6¾c. per gal. f.o.b. Bayonne, N. J.

St. Louis—June 8, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.10 per bbl.; 26@28 deg., $2.15 per bbl.; 28@30 deg., $2.20 per bbl.; 30@32 deg., $2.25 per bbl.; 32@36 deg., gas oil, 5.5c. per gal.; 38@40 deg., 6¼c. per gal.

Pittsburgh — June, 8 f.o.b. local refinery; 30@34 deg., fuel oil, 6¾c. per gal.; 36@40 deg., fuel oil, 7¼c. per gal.

Dallas—June 15, f.o.b. local refinery 26@30 deg., $1.70 per bbl.

Philadelphia — June 16, 27@30 deg., $2.31@$2.37 per bbl.; 18@22 deg., $1.93@$1.99; 13@19 deg., $1.81 per bbl.

Cincinnati — June 14, tank-car lots f.o.b. local refinery, 24@26 deg. Baumé, 6½c. per gal.; 26@30 deg., 6⅝c. per gal.; 30@32 deg., 7c. per gal.

Chicago—June 15, tank-car lots f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.30 per bbl.; 26@30 deg., $1.35; 30@32 deg., $1.55.

Boston—June 14, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.45c. per gal.; 28@32 deg., 5.8c. per gal.

New Plant Construction

Calif., Arcadia—City plans to purchase a booster pump for waterworks.

Calif., Dalano—City, S. G. Ladd, Clk., will receive bids until June 28 for one deep well turbine pump and motor, switchboard, etc.

Calif., Fullerton—Orange County Ice Co., A. W. Cleaver, Pres., plans the construction of an ice plant at Truslow and Harvard Aves. Estimated cost $11,500.

Calif., La Jolla—Union Ice Co., 110 West 1 St., San Diego, awarded contract for the construction of a 30 ton ice plant here, to A. E. Keyes, 1412 Dale St., San Diego. Estimated cost $60,000.

Calif., Los Angeles—Bd. of Supervisors will receive bids until July 6 for a deep well turbine pump for county farm.

Calif., Oakland—Drake Investment Co., c/o Miller & Pflueger, 580 Market St., San Francisco, Archt., is having plans prepared for the construction of a 21 story hotel at 18th, 19th, Jefferson Sts. and San Pablo Ave., here. Estimated cost $2,250,000.

Calif., San Diego—Syndicate plans the construction of a 13 story hotel on A St. Estimated cost $1,000,000. Parkinson & Parkinson, Title Insurance Bldg., Los Angeles, are architects.

Conn., Willimantic—City will receive bids until June 28 for improvements to waterworks including new pumping unit, etc. H. W. Taylor, 149 Broadway, New York, N. Y., is consulting engineer.

Ill., Chicago—E. W. Carlson, Pine Grove & Grace Sts., will soon receive bids for the construction of a 16 story apartment at Sheridan Rd. and Grace St. Estimated cost $2,500,000. Robert S. DeGoyler & Co., 307 North Michigan Ave., is architect.

Ill., Chicago—Seventy East Cedar St. Bldg. Corp., c/o McNally & Quinn, 8 South La Salle St., Archts., will soon award contract for the construction of a 17 story apartment at 70 East Cedar St. Estimated cost $1,250,000.

Ill., Chicago—Wille Bros., c/o Hooper & Janisch, 879 North La Salle St., Archts., will soon receive bids for the construction of a 21 story apartment at 1400 Lake Shore Dr. Estimated cost $2,500,000. F. A. Randall, 160 North La Salle St., is engineer.

La., Shreveport—Shreveport Ice & Brewing Co., awarded contract for the construction of an ice manufacturing plant to T. Green. Estimated cost $65,000. Bids will be taken later on machinery and equipment. Work will be done under the supervision of G. E. Wells, Security Bldg., St. Louis, Mo., Consit. Engr.

Mass., Greenfield—Dept. of Waterworks, plans the construction of a pumping station near Green River. Estimated cost $40,000. E. M. Schneck, is engineer.

Mass., Lakeville—Dept. of Public Health, awarded contract for the construction of a pumping station to F. A. Mazzur Co., 141 Milk St., Boston. Estimated cost $25,000.

Mich., Detroit—Dept. of Water Supply, G. H. Fenkell, 176 East Jefferson Ave., will receive bids until June 29 for the construction of a transformer station and switch house for waterworks.

Mich., Flat Rock—Ford Motor Co., B. R. Brown, Const. Dept., Highland Park, plans the construction of an addition to boiler house including three boilers, coal conveyors, etc. here. A. Kahn, 1000 Marquette Bldg., Detroit, is architect and engineer.

Mich., Jackson—City, F. R. Harris, Mgr., will receive bids until July 6, for the construction of a sewage pumping station including pump pit, motor room, etc. G. D. Kennedy, is engineer.

Minn., Minneapolis—Bd. of Education, 305 City Hall, G. F. Womrath, Bus. Supt., will receive bids until July 1 for refrigerating machinery for high school.

Minn., White Bear Lake—City, L. M. Rief, Clk., will receive bids until July 7 for the construction of a sanitary sewage system, sewage disposal plant, two pumping stations, etc.

Miss., Gulfport—Markham Hotel Co., c/o A. L. Jagoe, First National Bank, plans the construction of an 8 story hotel at 23rd Ave. and 14th St. Estimated cost $1,000,000. J. W. Billingsley, Interstate Bank Bldg., New Orleans, La., is architect.

Missouri — Missouri Hydro Electric Co., Land Bank Bldg., Kansas City, has been granted preliminary permit by the Federal Power Commission to construct a hydro electric power project on Current River in Shannon, Carter and Ripley Counties. Plans include an 84 ft. dam at Hargus Eddy and a 194 ft. dam at Mill Creek about five miles above Van Buren. Initial capacity 21,000 hp., ultimate total capacity 45,000 hp.

Mo., St. Louis—Local syndicate, c/o H. R. Weisels, Inc., 730 Chestnut St., and Holbrook-Blackwelder Real Estate Co., 1010 Olive St., is having preliminary plans prepared for the construction of a 15 and 37 story hotel and office building at Olive, Pine, 12th and 13th Sts. Estimated cost $10,000,000. G. D. Barnett, 913 Syndicate Trust Bldg., is architect.

N. Y., New York—S. Aginsky, c/o G. G. Miller, 1482 Broadway, Archt., will build an apartment on University Ave. Estimated cost $800,000. Work will be done by separate contract under the architect's supervision.

N. Y., New York—Fortieth St. and Park Ave. Corp., c/o V. C. Farrar, 1 Pershing Sq., Archt., is having plans prepared for the construction of a 21 story office building at Park Ave. and 40th St. Estimated cost $1,000,000.

N. Y., New York—Phipps Foundation for Working Girls, H. P. Phipps, 787 5th Ave., awarded contract for the construction of a 15 story hotel at 56th and First Ave., to M. J. Kramer, 1 West 57th St.

N. Y., New York — Stoneman Realty Corp., c/o G. G. Miller, 1482 Broadway, Archt., is having plans prepared for the construction of a 6 story apartment on Park Terrace. Estimated cost $700,000.

N. Y., White Plains—Westchester County Bd. of Supervisors, Court House, will soon receive bids for the construction of a 10 story office building on Court St. Estimated cost $800,000. B. W. Morris, 101 Park Ave., New York, is architect.

Okla., Boise City—City plans improvements to waterworks including pumping plant, 40 to 60 hp. oil or gas fuel engine, 50,000 gal. aerial tank, etc. Estimated cost $18,000. E. W. Gantt Engineering Co., West Main St., Oklahoma City, is engineer.

Okla., Chickasha—City plans improvements to waterworks including engines, pumps, etc. Estimated cost $125,000. Rob. O. Bradley & Co., are engineers.

Pa., Lewistown — Viscose Co., Marcus Hook, awarded contract for the construction of addition to power house on Juniata River here, to W. B. Steinbach, Lewistown. Condenser, flow generator and other equipment will be required.

Pa., Philadelphia — Pennsylvania R.R. System, Broad St. Station, Montgomery Smith, Purch. Agt., will receive bids until June 25 for a locomotive boiler, etc.

R. I., Providence—Industrial Trust Co., Westminster St., is having plans prepared for the construction of a 23 story bank and office building. Estimated cost $2,000,000. Walker & Gilette, 128 East 37th St., New York, N. Y., are architects.

S. D., Huron—Lampe Meat Market is in the market for complete refrigeration equipment for proposed market. Estimated cost $125,000.

Tenn., Nashville—Thomas Henry & Sons Inc., Trenton Ave. and Tioga St., Philadelphia, Pa., awarded contract for the construction of a factory including boiler room, etc. at 63rd and Centennial Blvd. here, to A. K. Adams Construction Co., 247 Clifton Rd., Atlanta, Ga. Estimated cost $250,000.

Tex., Greenville—N. Burnett, is having preliminary plans prepared for the construction of a 25 ton ice plant. Estimated cost $45,000. Private plans. Machinery will be required.

Tex., Houston — Suburban Development Co., c/o F. S. Glover, Pres., 604 Binz Bldg., is having plans prepared for the construction of a 15 story hotel at Main St. and Rosalie Ave. Estimated cost $1,000,000. L. A. Grover, 604 Binz Bldg., is architect.

Tex., Luling — L. H. Bridges & J. T. Dickens, plan irrigation of about 3,000 acres on Plum Creek including pumping equipment. Estimated cost $60,000. Private plans.

Tex., San Antonio—Crystal Ice Skating Rink, F. Beddoe, Mgr., National Bank of Commerce Bldg., plans the construction of an addition to ice skating rink including a 12 ton additional refrigeration system. Estimated cost $50,000. G. Willis, Builders Exchange Bldg., is architect. Machinery will be required.

Wash., Mayfield—Grays Harbor Railway & Light Co., W. W. Briggs, V. Pres., Aberdeen, plans the construction of a 207,000 hp. hydro-electric development on the Cowlitz River. Total estimated cost approximately $20,000,000. Plans are under way for the first unit to be built at Mayfield, two other units will be built later. Initial capacity of the three units 48,000 hp.

Wash., Seattle—Puget Sound Power & Light Co., Stuart Bldg., will receive bids until July 7 for the construction of a service station at Eighth and Roy Sts. Estimated cost $200,000. J. Graham, Dexter Horton Bldg., is architect.

Wash., Shelton—W. H. Blay has filed application with Federal Power Commission for permit to use 30 cu.ft. of Mill Creek and Lake Isabel for hydroelectric development. It is proposed to turn Lake Isabel into a reservoir by constructing a 750 ft. crib dam. Estimated cost $60,000. The plant will provide water for manufacturing purposes.

W. Va., Parkersburg—Viscose Co., Marcus Hook, Pa., awarded contract for the construction of a power and boiler house including generator and condenser rooms, etc. near here, to John P. Pettyjohn, Lynchburgh, Va. Equipment contracts will be awarded later.

Wis., Milwaukee — E. D. Fryer, 1432 Stowell Ave., awarded contract for the construction of a 4 story cold and dry storage warehouse on South Water St., to H. Danischefsky, 1484 Humboldt Ave. Estimated cost $400,000. Owner is in the market for refrigeration machinery.

Wis., Two Rivers—Aluminum Goods Mfg. Co., 15th and Franklin St., Manitowoc, awarded contract for reconstruction of boiler house here, to W. W. Oellein, 86 Michigan St., Milwaukee. Estimated cost $60,000.

Wis., Two Rivers—Hamilton Mfg. Co., will soon award contract for the construction of addition to plant including boiler house, two 350 hp. bent tube boilers, stokers and coal handling apparatus. Estimated cost $80,000. Lockwood, Greene & Co., 400 North Michigan Ave., Chicago, Ill., are engineers.

B. C., Vancouver — Vancouver General Hospital, Tenth and Willow Sts., plans the construction of a hospital. Estimated cost $1,758,000. A. J. Bird, Holden Bldg., is architect.

B. C., Vancouver—Vancouver Syndicate, c/o McCarter & Nairre, Archts., 509 Richards St., is having sketches made for the construction of a 10 story hotel on Georgia St. Estimated cost $5,000,000.

Ont., Niagara Falls—Canadian Shredded Wheat Co., awarded contract for the construction of a new heating plant including boilers, etc., to Babcock Wilcox Goldie McGullough Co., 64 West Main St., Galt. Estimated cost $75,000.

Ont., Tillsonburg—Regal Oil Co., W. B. Brooks, Pres. and Gen. Mgr., 704 Confederation Life Bldg., Toronto, awarded contract for foundations of 14 buildings including pump and boiler houses, etc. here, to Orr & Clark, 121 Carlaw Ave., Toronto. Estimated cost $75,000. Total estimated cost $250,000. Contracts for superstructures will be awarded later.

Ont., Trenton—Hinde & Dauche Paper Co., 43 Hanna St., Toronto, is in the market for paper making machinery and electric motors for proposed strawboard paper mill. Estimated cost $350,000 to $450,000.

N. Z., Wellington—Public Works Supplies and Tenders Board, will receive bids until Sept. 28, for a pumping station including 3 motor driven pumps.